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ANIMAL PARASITES OF MAN AND THEIR CONTROL[1]

By Dr. ALFRED C. REED

PROFESSOR OF TROPICAL MEDICINE, UNIVERSITY OF CALIFORNIA

SOME years ago a party of travelers lost its way on a by-road down South, coming finally to a cross-roads store. Against one corner leaned a lethargic, malaria-ridden cracker, meditating over the chewing of a straw. The driver of the automobile hailed him, "Is that the highway yonder?" "I don't know." "Where does the road go at the fork ahead?" "I don't know." "You don't know much, do you?" "No, I don't know much, but I'm not lost." That is our position to-day with reference to the animal parasites of man. Their tremendous number and fecundity, the mystery of their origin, our lack of specific or any treatment in many cases, our defective knowledge of their natural history, our ineffective methods of control, our feeble prognosis of their future relations to man—these things make us humble in the face of this great broadcast system of parasitism. It is worthy of study for three reasons: because of pure academic interest, because of the clinical and public health need of control, and because in it is written the foundation of human history.

Parasitism is a term coming down from the ancient Greek days of parasites—sharers of the feast, or messmates, to whom no stigma attached, or reproach or contempt. Religious parasites were attached as assistants to the priests to collect the corn dues from farmers on the temple lands or from other sources. It was their province to provide food for temple visitors, to care for certain offerings and to arrange the sacrificial banquets. On the other hand, civil parasites were persons who received invitations to

[1] Presented before the Pasteur Society of Central California, Clift Hotel, San Francisco, September 24, 1930. From the Pacific Institute of Tropical Medicine within the George Williams Hooper Foundation for Medical Research, University of California, San Francisco, California.

dine in the prytaneum as distinguished from those who had the right to dine there *ex officio*. (The prytaneum was the official and religious center of the community.) Much later, the term parasite evolved to mean a person who would submit to any indignity or humiliation in order to obtain a good dinner, in other words, a "sponger." Plautus describes such parasites in his comedies. Alciphron and Athenaeus detail the various insults they endured from hosts and guests alike. Some of these parasites became professional jesters, like the court fools and buffoons of a later age. Some relied on flattery to secure free feasts. Others practiced various degrading vices to achieve their end.

The evolution of the word "parasite" more than suggests the story of the evolution of parasitism as used in biology. In each case the species begins with a free-living form, independent and with diversity and good development of functions. By natural accident, these free-living forms were placed in temporary close relationship with potential hosts. Some few sacrificed independence, locomotion, individual defense and various special senses (moral or physical), in order to secure an abundant food supply and protection. This led to a one-sided development of adaptation or sycophancy, with a stimulation of reproduction and simplification of structure and function. In the end, in each case, we find a parasite incapable of existence aside from its host, and so modified by adaptation to its host that little resemblance remains to its free-living ancestors. Thus we consider as parasites such animal organisms as live upon, within or at the expense of other animal organisms. Parasitism means the relationship obtaining between the parasite and its host.

Origin and Evolution of Parasitism

Chiefly for want of a better thesis, it is commonly assumed that the animal parasites of man originated from free-living forms. For each parasitic form there is a considerable and often very large number of closely related free-living forms. There is no such thing as a group or class of parasites since almost every animal group contains actual or potential parasites. Fantham says that parasitism, biologically, is in no sense a matter of structure, but is very definitely a manner of existence. It is a habit which theoretically may be assumed by almost any living organism.

The usually accepted mode of parasitic evolution assumes that free-living forms of animals are older than parasitic forms, since free-living forms must have been in existence before they could find hosts to parasitize. This is almost a paranoid type of argument because it may well prove to be founded on a false hypothesis. No one ever saw a free-living animal change into a parasitic form. The pure theory of mutation of species has proved a serious stumbling block in general evolution and is just as great an obstacle in the evolution of parasitism. We *know* absolutely nothing as to the real origin of parasitism and processes of change which we observe in fleeting glimpses may be proceeding either forward or backward. It is possible to change the habits of a free-living animal so that it adapts itself to a variable degree to a host in a parasitic relation. It is also possible to take a parasitic form and train or adapt it to a more or less independent free-living form. Which is the archetype? We do not know. We assume and infer, and our *method* is correct because we plant a germ of observation and out of it grows stalk and leaf of hypothesis, and then the blossom of full-grown theory, and a promise eventually of obtaining a modicum of fruitful truth. So that while we must theorize, it must be with the effort to improve the theory with wider and keener observation and experiment, realizing that the final truth is far off and possibly very different from the ideas we entertain en route toward it.

Having assumed that animal parasites originated from free-living archetypes, we are next confronted with the difficulties of the general evolution theory itself. Three major types of general evolution have been advanced and each of these offers interesting and self-evident bearings on the problem of the evolution of animal parasites. First of these is the Darwinian theory of mutation through continuous and long-continued variation. The second theory of DeVries considers species to have arisen through sudden and irregular mutation as environmental circumstances for a time became favorable to such changes. The third theory has recently been propounded by the Dutch botanist, J. P. Lotsy, who believes that new species have arisen by crossing of dissimilar parents. Lotsy insists, in spite of the plausibility of the mutation theories, that it has never been really proved that a new species arose in this manner. The only new forms produced experimentally, have been a result of hybridization. He considers it quite possible that the main divisions of organic life originated from hybridization. A fourth theory from a completely new view-point challenges attention for its novelty, close-knit argument and the unique application to biology of the present-day knowledge of atomic physics. Those interested should read the recent volume entitled "What is Life?" by Dr. Augusta Gaskell, and the thought-provoking introduction by Raymond Pearl. Dr. Gaskell applies the principles of atomic physics to the problem of the origin and

nature of life. It is her contention that species may arise *de novo*. Her argument raises many interesting questions in connection with the development of parasitism.

It is usually believed that external or ecto-parasitism evolved before endo-parasitism, the reason being that the change from free-living to ecto-parasitic existence seems less radical and abrupt than the change to endo-parasitic existence. For instance, some more occasional or partial parasites took their human host solely at mealtime as in the case of the leech (Hirudo) and the bedbug (Cimex). This is more a predatory relation and is much less difficult to establish than the relation necessary for a parasite in the intestine or the blood stream. The parasitic habit seems to have arisen separately and independently in most large groups of animals and therefore might be considered of rather common occurrence in the course of general evolution. This is shown by the presence of free-living as well as parasitic types in most large animal groups.

We must consider that, in general, parasites belong to animal groups more primitive than their hosts, that is, to groups of a less specialized and less highly developed type. In the case of protozoa, the rule still holds because protozoa are parasitized by plant organisms. Some ecto-parasites are not limited to one species of host. Others are so limited and some even to a single part of the host's body. These types are assumed to be evolutionary stages of ecto-parasitism. The most primitive stage is probably where the ecto-parasite is able to migrate from one species of host to another. With more specialization it becomes limited to a single host species, and finally to a single part of that host.

The relation of ecto-parasites to endo-parasites affords much food for speculation. Many believe that symbiosis and commensalism lead to parasitism. For instance, an organism that takes its meals in a state of mutualism with another organism, may easily become a food robber, and then a parasite. Or again, symbiotic relations may be disturbed so that one organism gradually becomes pathogenic for the other. Such a situation would help explain the moot question of pathogenicity of *Entamoeba coli*, for example. In general we assume that endo-parasitism arose (1) from ecto-parasitism, (2) from commensalism, or (3) from symbiosis. An endo-parasite restricted to one species of host is probably no older in race than its host and changes in the parasite have probably been coincident with changes in the host. An endo-parasite found in several species of hosts probably is older racially than these hosts, and has adapted itself to hosts which evolved after its parasitic habit was established.

Faust has introduced the logically correct term "guest," for a parasite in relation to its host. In the case of helminths, he suggests that the relation was first one of chance contact only, whereby a free-living guest was carried from one feeding ground to another. Sooner or later the guest began to use food procured by the host, and gradually became more and more dependent on such food Some of the guests then began to consume the tissues or juices of the host itself, either by use of suctorial organs or by actual penetration of and residence in the host's tissues. This resulted in a very degenerate and dependent parasite. Forms living in the blood or lymph, such as filaria and blood flukes—in the muscles, such as trichina—or in the pleura and peritoneum, such as hydatids—are usually most highly modified or adapted and may therefore be considered the oldest parasitic species. Other forms living in the mouth, bladder and other epitheliated organs, or as ecto-parasites on the skin, are frequently very young in parasitism. This is demonstrated by their relatively slight modification from the archetypes of the group and from related free-living forms. It often happens that the adult parasite undergoes only slight modification, while the larva, or intermediate form, is highly modified.

Greater length or age of parasitism means greater modification away from the archetype of the species. This means practically greater simplification of the parasite. Change of environment from a free-living existence to one of abundant and assured food supply, and increased protection against enemies, leads to atrophy of certain functions and structures. This is not degeneracy, but evolution; not retrogression, but orderly change. Herein, perhaps, lies a warning to the advocate of return to a so-called simple life. The simple life connotes protection and a free-lunch counter. The result is social parasitism.

Faust states that simplification, which is synonymous with adaptation, is illustrated in the helminths by reduction in organs of locomotion, except in free-living larval stages. An even more radical reduction takes place in the organs of alimentation. In tapeworms, for example, the digestive tract has entirely disappeared except for possible vestiges in early larval stages. The integument has been simplified to afford protection against digestion and abrasion by the intestinal contents, and to permit attachment to the intestinal wall by suckers, hooks or by penetration. On the other hand, the reproductive system has increased enormously and this makes a serious

public health problem. The nervous and excretory systems have suffered little change. There is a striking contrast between the influence of an easy life on reproductivity in parasites and most of the animal kingdom, and in man. In man it is as Adam Smith said, "Poverty seems favorable to generation. But poverty, though it does not prevent generation, is extremely unfavorable to the rearing of children."

As we approach the problem of the host in relation to the parasite, it seems probable that parasites using intermediate hosts have evolved from parasites having but one host. At first, the parasite would have merely tolerated the second host, then would have adapted itself to the second host, and finally established itself in some stage in the second host. Nature provides numerous examples of the entrance of exogenous stages of parasites into other animals and therefore abundant opportunity exists for parasitism to develop and for intermediate hosts to enter the cycle. Adaptations often of unusual nature are necessary to permit the parasite in its larval or oval form to reach the intermediate host. This is nicely portrayed in the life cycle of the guinea worm, of flukes and of hookworm.

The problem of intermediate hosts is far from settled. R. Leuckardt believed that the present intermediate hosts were the original or primitive hosts both for larval and adult forms. Parasites then gradually differentiated and developed into later and more numerous stages, which in turn gradually sought out new definitive hosts. The earlier stages remained in the original hosts, now called intermediate hosts. This theory at once meets with objections.

On the contrary, R. Moniez considers the present definitive hosts to have been the original ones, and that ascaris, trichinella and enterobius, for instance, have continued this primitive relationship. In most other cases embryos, which were potential parasites, were unable to resist or endure the chemical and mechanical influences of the intestinal tube. They therefore left the intestine by penetrating its walls and burrowing through into the tissues of their carriers or the primitive hosts. Here they could attain a fair degree of development, but were mechanically prevented from returning to the intestine where their eggs could be deposited. Most of them died out as parasites, just as their young stages do now if they reach a wrong host. Nevertheless some of them passively were carried into the intestinal tract of beasts of prey. Many perished in the process of digestion, but a few reached the intestine undamaged. These grew, became more resistant and developed into adult forms. Gradually this process became established by heredity, and became usual and normal. This is an attractive theory and has in it much to commend.

Under unusual or special conditions parasites may invade unusual hosts. They then tend to aberrant locations and are often very dangerous, as shown by *Cysticercus cellulosae,* for instance. A common example is also seen in the so-called larva migrans, or creeping eruption, due to larvae of non-human nematodes, such as the dog hookworm, penetrating human skin and crawling about in the subcutaneous tissue. It is possible that *Loa loa* may represent a similar condition.

In general, true or strict parasites have specific hosts. The great exception to this rule is *Trichina,* which is found in man, pig, bear, rat, mouse, cat, fox, badger, skunk and marten, and can be artificially cultivated in the dog, rabbit, sheep, horse, other mammals and in birds. Intestinal and ecto-parasites are usually less dangerous than blood and tissue parasites. The origin of host-parasite specificity is the same as the evolution of parasitism.

Faust emphasizes that, as a host, man, like other animals, suffers more from parasites if they are relatively new to him. Long acquaintance brings tolerance, here as everywhere. In fact, we might well paraphrase the insight of Pope's famous lines in his "Essay on Man," and say:

> Parasites are monsters of so frightful mien,
> As to be hated, need but to be seen;
> Yet seen too oft, familiar with their face,
> We first endure, then pity, then embrace.

Negroes are less disturbed than whites by intestinal worms. Chinese are commonly little affected by clonorchis. The Asiatic child is less upset by ascaris. Perfect adaptation of parasite to host means a complete absence of symptoms. This principle is seen clinically illustrated in the case of infection with *Entamoeba histolytica.* If the parasite is poorly or badly adapted, symptoms arise. Millenniums of association in the host-parasite relation definitely seem to decrease pathogenicity. This gradual racial immunity has many counterparts in clinical parasitology. Even California fleas prefer the fresh blood of newcomers. We have no answer, as yet, to the question as to why insects exercise a selectivity at times in the individuals they select as donors for transfusion. Yet such selectivity exists at least in the case of fleas, bedbugs, mosquitoes and sandflies.

Enough has been said to indicate the extreme complexity of the world of animal parasites. With so little definite information on the subject of the origin and evolution of parasites, we are forced to base practical measures of control on studies of para-

sitism as it exists to-day. Certain features of parasitism are of special interest, therefore, when we come to consider the principles on which specific control may be based.

HOST-PARASITE RELATION

Granting a condition of parasitism, the optimum habitat for the parasite is provided when there is the least possible or no damage to the host. The host-parasite relation must be considered as a finely adjusted balance of biology, in which the parasite must preserve itself and perpetuate its race, and in which the host must not be sufficiently irritated or damaged to react in such a way as to prevent achievement of these two objects by the parasite. This is illustrated with nicety in the case of *E. histolytica* in relation to its host.

For infection of the host, it is necessary that host and parasite have the same geographic distribution, the habits of the host must bring it in relation with the infective stage of the parasite, and the infective stage in the life cycle of the parasite must be reached at the precise time the host is available to be parasitized. Numerous remarkable adaptations occur as a result of the need of meeting these requirements. Some of these can be indicated as follows:

1. Guinea worm—Cyclops—ingested by man.
2. *Leishmania* and *Loa* in skin (Sandfly and *Chrysops*).
3. Leeches (*Hirudinei*). *Limnatis nilotica* in drinking water, lodges in nose and pharynx. (See Alfred Russell Wallace and Loos, *Haemadipsa* species.)
4. *E. histolytica*—cysts to exterior—to new host.
5. Hookworm—intermediate cycle.

It has been mentioned that parasitology has a contribution to make to the prehistoric record of man. This is illustrated by a type of reasoning first developed by von Jhering in 1902.[2] In the case of parasitic worms von Jhering argues that if the same or nearly the same species of worm parasitizes two or more species of hosts, then the hosts descend from a common ancestor. The similarity of the helminth parasites indicates their origin also from a common ancestor. Thus, apparently, the different species of hosts involved all descended from a primitive ancestor which was parasitized by the original ancestral parasite.

Zschokke has applied a similar argument to the distribution of certain cestodes in marsupials. He also claims that the original home of the salmon is in the salt ocean because the larger proportion of its endoparasites are marine. Thus the path of salmon migration and its breeding grounds are no index as to whence it came. Zschokke says, "Each parasite fauna comes to be to some extent a mirror-image of the biology of the host, of the host's habits of life, and especially of the host's relations to those creatures that share the habitat with it. Each change of nourishment and residence of an animal finds its echo in the changes in the helminthic condition."

Metcalf has discussed the distribution of the family *Leptodactylidae*. These are frogs characteristic of tropical and sub-tropical America, and also of Australia and Tasmania. They have been reported from no other parts of the world. Only two explanations of this distribution are possible. (1) Assumption of an earlier land bridge across Antarctica, connecting South America with the Tasmanian-Australian plateau. (2) Convergent or parallel evolution. This frog family harbors an opalinid rectal parasite of the genus *Zelleriella* which is present in both geographic groups of frogs. So nearly alike are these opalinids that their species separation is most difficult. It is possible that either the frogs or the opalinids arose by parallel or convergent evolution. But it seems utterly impossible that *both* frogs and opalinids developed such a similarity in the two geographic areas. Therefore we must assume a primeval land bridge.

Kellogg has applied this reasoning to bird lice, Johnston to trematodes and cestodes. Darling studied the migrations of the human race from data on hookworm distribution. The method is valid and opens the way for much valuable new work on human geography and evolution. This is especially hopeful because parasites include the latest known examples of biologic evolution (Metchnikoff).

The principles of parasite control are to-day too specialized, varied, empirical and ineffective because of insufficient data in certain definite lines. These are chiefly: (1) Data on evolutionary development and individual life stages as influenced by external factors. (2) Distribution of parasites and extent to which they can and do enter other hosts than the principal one. (3) The extent to which behavior of parasite and of host influences or determines specific relations between the two (Hegner). (4) The factors in the host which favor invasion and establishment of so-called natural parasites and obstruct similar entry and establishment of foreign parasites (Hegner). (5) Reasons for laboratory, experimental and accidental infections in foreign hosts (Hegner). (6) Understanding of immunity and susceptibility in hosts, racially, from heredity, difference between individual hosts of same species, and between young and adult hosts. (7) The reactions between host and parasite which terminate an infection or cause latency

[2] See Hegner, Root and Augustine.

or relapse. Better data on these points will greatly improve methods of control.

The extremely small number of infective forms which reach a new host necessitate an enormous fecundity in parasites. Transfer to new hosts may be purely passive, by contaminated food or drink, by direct contagion, by inoculation, or may be pre-natal. *Therefore simple sanitary measures are usually sufficient to prevent individual infection.*

Before taking up the specific problem of parasite control it will round out the entire subject to review, briefly, current ideas on the antiquity of animal parasites, especially helminths, in man. Faust states that parasitism was well established before the dawn of human history. All the common species of human parasites are much older than the genus man. This statement is based on the following considerations: (1) Many infections of man are also common in animals, and man is only incidentally or accidentally infected. (2) Some infections are decidedly pathogenic for man but not for other animals. (3) Many parasites which now use two or more hosts, including man, probably originally used only one host, the one in which their larval stages now appear. (4) Certain groups of parasites of man and other mammals have a similar or identical morphology but widely different physiologic processes. This indicates that the parasite has been established in man long enough to have acquired a relatively fixed adaptation. (5) Strongylus, for example, is a fairly recent parasite of man because its free-living stages, which are reproductive, can probably continue indefinitely outside the human host. Hookworm has a much longer parasitic history, while ascaris, trichocephalus and enterobius are extremely old in parasitism and their entire life history is carried on in man. Parasites of the blood and lymph are the oldest of all and have undergone much more profound adaptations, especially in physiology.

The ancient story of parasitism is nicely summarized by Faust. Long before the dawn of history, at least 100,000 years ago, hunters of wild oxen and boars became infected with tapeworms, ascaris and trichina. Primitive fishermen, eating raw fish, acquired *Diphyllo bothrium* and the liver fluke. Herdsmen were infected with hydatids from sheep and dogs. Guinea worm infection and filaria have a similar antiquity. As man settled down and began to till the soil, he came in closer contact with his own race and bad hygiene exposed him to fecal contamination. Hookworm, strongylus, ascaris and trichocephalus became endemic. In the great valleys of the Nile and Yangtze, fishermen and farmers wading in stagnant water were infected with schistosomes. Man's associate, the rat, conveyed hymenolepis, and became a reservoir for trichina, while the dog flea conveyed dipylidium. Thus at the dawn of history, helminth infection at least was distributed through the inhabited world, but more intensely through the tropics.

Vesical schistosomes have been found in Egyptian mummies of the 13th century B. C. Moses separated clean from unclean animals on the basis of their visible infection with parasites. This was especially so in the case of goats and kids offered for sacrifice and later eaten. Syrian goats are heavily infected with *Fasciola hepatica* and persons eating infected raw livers get a disease called "halzoon," or pharyngeal fascioliasis. All scavenger birds and beasts were prohibited as food, including hogs, camels, birds of prey, reptiles, snails and others. They were prohibited because their flesh was infected with parasites. All animals not on the prohibited list, whose flesh was found infected, were to be burned. Moses warned against infected water, containing cyclops and cercariae. He taught the people by his brazen images of the fiery serpents how to extract the guinea worm. Later the people were instructed to drink water from their hands instead of lapping it up, possibly to avoid leeches. Many references record the acquaintance of the ancients with animal parasites.

CONTROL OF ANIMAL PARASITES

Nearly every group of fauna has in it parasitic species. From the social point of view, this is also eminently true for man himself and brings up the whole field of social human parasitism which has been very insufficiently studied from the biologic point of view and from the standpoint of human geography. In the phyla of the animal kingdom, some have only a few parasitic forms, but three phyla contain a large number, in fact, a majority of animal parasites. These are the protozoa, arthropoda and several phyla of worms.

The general principles on which control must be based have already been discussed. It remains to consider broadly the large parasite groups, commenting on control methods in relation to each. We deal with Worms, Protozoa and Arthropods.

I. WORMS: The spread of helminths requires the presence of proper intermediate hosts, of suitable climate and moisture, available definitive hosts, and proper interrelations between these and the general environment.

The spread of helminths is determined largely by certain factors which are more or less subject to human control and which therefore offer the practical points of attack on the problem.

1. *Food:* Faust gives many examples of the importance of the type of local native food. Thus the Chinese and Hindus thoroughly cook most of their food, which is largely eaten hot. (Note also the importance of the tea habit.) However, in China and India some cooked food stands in stalls and restaurants, covered with flies and dust, and exposed to domestic animals, roaches and vermin. To all this the people are oblivious, since they completely lack a sanitary sense. We see analogous food exposure in nearly all countries: in Italy and France, the bread; in England, the milk; in the United States, berries, vegetables, fruits and salads are often exposed to flies, dust, expectoration, dogs, cats, rats and mice, etc. In the orient and most of the tropics, all foods raised in the ground are invariably contaminated. Many are kept fresh in the bazaars by sprinkling with dirty water applied by whisks or blown by the mouth. In China, water chestnuts, the gigantic Chinese radishes, lotus roots and bamboo shoots are eaten raw. From Egypt to Iraq sticky sweetmeats, drowned in flies and dust, are consumed by rich and poor alike. Sugar-cane sections are kept fresh in dirty water. China gives a hypo of dirty water to oranges beginning to wither, just as she soaks melons and cucumbers in dirty water after tapping their skins with stiff bristle brushes, and then sells them honestly by weight. Fresh berries, celery, lettuce and other salad plants are anathema in the tropics, yet the plain laws of common-sense and sanitary sense are ignored by native and foreigner alike.

Chinese and Indians eat the water ling and chestnut by peeling off the outer petals with their teeth, and become infected with the cysts of *Fasciolopsis buski.* In China and Formosa, the same result follows eating certain raw grasses. It is common knowledge among the farmers of central China, where *Fasciolopsis* is abundant, that hogs raised in the courtyard escape it, while those raised on the hillside get it. Yet the farmers do nothing whatever about it. The situation reminds one of our own ignoring of well-known sanitary facts in sewage disposal on the farm, as well as in garbage disposal in the city.

In general the Chinese do not eat raw fish and arthropods as do their neighbors around the China Sea, but in some parts they eat large quantities of dried fish. Raw fish and arthropods spread flukes, especially metagonimus, clonorchis and paragonimus, broadcast in Japan, Formosa, Korea and Tonkin. In the wetter parts of China, clonorchis and metagonimus are found in cats and dogs. Several central provinces of China, especially Fukien, Kiangsi and Hunan, have paragonimus infection in tigers, panthers and wild cats, just as in Korea, Siam and Assam. Attention must be drawn also, in connection with food as a spreader of parasites, to the importance of the dirty fingers or utensils with which the food is eaten. The chopsticks of eastern Asia are more sanitary than the vilely contaminated fingers of Mongolia, the Near East and Arabic countries.

2. *Water,* as a means of transfer of helminths, is never safe in the orient or tropics, and often unsafe elsewhere. Examples of water transfer are seen in the cercariae of various flukes and the larvae of the guinea worm.

3. *Nightsoil* is perhaps the chief potential source of human helminth infections. In the orient and tropics nightsoil is universally used as a fertilizer for the fields. The sights and smells of this traffic beset the landscape and offend the senses in city and country alike. By this means virulent bacteria and numerous parasites are propagated and broadcast over the land. Not only are the farmers and coolies subject to infection, but field produce, vegetables, fruits and melons, are all grossly contaminated and carry contagion to those who eat and drink without thought for the morrow. The use of nightsoil as fertilizer is a logical and economical system. In the West the form of fixed nitrogen most valuable for plant use is entirely wasted by our wasteful and short-sighted conservancy methods. The Chinese method is effective, saving, logical, but unesthetic and disease-breeding. Parasite control must go hand in hand with good economics and a reasonable degree of esthetics.

4. *Migration and Travel:* Negro slaves from Mozambique and the Gold Coast probably brought hookworm and Manson's schistosome to America. The former needed no adaptation and the latter found *Planorbis* snails awaiting it as intermediate hosts. The fish-tapeworm was carried to Switzerland a thousand years ago by Swedish emigrants and to the United States and Canada by Scandinavian emigration. Wherever Islam spreads, *Taenia solium* disappears and *Taenia saginata* becomes endemic. Travel and migration are of great importance in spreading all parasites. Conversely, parasites are important in diverting or causing emigration. In the seventh century the Moslem invasion of North Africa did not cross the Sahara because all livestock was inoculated with trypanosomes by the tsetse fly at the southern borders of the desert.

5. *Influence of racial and local habits,* food customs, manner of eating, bathing, clothing, housing, conservancy, occupation and religion. These things all have an important bearing on helminth spread and practical means of control.

6. Spread of helminths depends to a considerable

degree on the presence of vectors and proper intermediate hosts. Plants may act as vectors as where they harbor encysted fluke larvae, and where heavy fleshy roots are parasitized by plant nematodes and then eaten by man. Invertebrate intermediate hosts belong to the two large phyla of molluscs and arthropods. Vertebrate intermediate hosts include fish, reptiles, amphibians and occasionally birds and mammals.

The public health aspect of parasite control is highly important. Carriers, either as intermediate hosts or as simple vectors, with or without symptoms, must be prevented from introducing parasites to new hosts. Studies of reservoir hosts need to be pushed. Human parasites in animals are important and little is known about them. A helminth can easily become epidemic in an area because of massive dosage or unusually favoring climatic conditions. Generally helminth infection is endemic and when once established with intermediate hosts, if needed, constitutes a vicious circle extremely difficult to break. One must search for the weakest point locally in the life cycle, with considerable knowledge of the evolution and biology of the parasite, in order to decide the most amenable point of application for preventive measures. In all parasitology, prevention is vastly more important than an attempt at control by cure. Human exposure can be minimized by public education in methods of spread and manner of entry into the body, as has been done in the case of hookworm disease. Wholesale treatment of patients has its function (1) in the clinical needs of the patients themselves, and (2) more vital from the public-health view-point, in protection of intermediate hosts and vectors from infection, and in preserving water and earth from infection. Control measures therefore may be directed to the intermediate hosts as in the schistosome problem of Egypt; to protection of the intermediate host from infection, as in the prophylactic use of quinine against malaria; to protection of man from entry of the parasite, as in the case of guinea worm and numerous other parasites; to cure of the infection in man; to improved personal hygiene, sanitation and conservancy.

I. HELMINTH PARASITES: This field is fairly familiar to medical workers and can be summarized briefly. Of the parasitic worms, we deal chiefly with the following groups: trematodes; cestodes, including hydatid; round worms, subdivided into the hookworm group including strongylus, ascaris and enterobius, and the filariae. The principles already reviewed are applied to each of these in its local setting with reference to environment both physical, biologic and social. In the case of filaria, we have to admit little progress and less knowledge. This widespread and dangerous group of worms has so far been refractory to control because of unknown factors of evolutionary development, life history, biology and psychology. The need and opportunity for new experimental work here is obvious.

II. PROTOZOA: Turning now to the second great parasitic group, the protozoa, we find practically every point applicable which was mentioned under the general control of parasites. These need not be repeated. The groups of protozoal parasites most important to man are as follows:

1. *Malaria:* Here it must not be forgotten that it is perhaps more important to protect the mosquito than man against malaria. If human disease is controlled there will be no transmission. If certain species of anophelines alone are controlled, others will take up their duties.

2. *Leishmania:* Here we have theoretically two methods of control, by eradication of sand-flies and by cure of patients. The former can not be done. The latter is effective on a wholesale scale.

3. *Coccidiosis:* Coccidial infection is so rare that little can be said as to its control. Probably, however, it is a late example of parasitism which longer adaptation may spread more widely and make more serious. It therefore needs detailed study to allow exact control to be instituted before it becomes a serious human parasite.

4. *Trypanosomiasis:* Space forbids even mention of the exceedingly interesting work being done in Africa on the control of trypanosomiasis. Various governmental institutes and numerous private organizations and individuals are involved and the outlook finally is hopeful. For American trypanosomiasis, or Chagas disease, not so much can be said.

5. *Rabies* is world-wide in its distribution and is rampant in the orient and all tropical countries, largely because of religious *beliefs* or indifference, which allow a large predatory and scavenging dog population. Similar factors are operative in the United States. For human purposes, control lies in dog control. This is to-day an impossibility in most countries, especially in hot latitudes. Even in the United States we are afflicted with that superparasite, highly adapted and late in evolution, the sob-sister of science, Sentimentalism. Her disguises cover Eddyites, anti-vivisectionists, maudlin animal lovers and a host of misguided ignoramuses. The total effect of all these differs only in degree from the effect of Buddhist, Hindu and animistic beliefs, so far as disease control is concerned. At present the problem of the dog population, like many another sanitary problem, is insuperable in most parts of the world. Nevertheless, Pasteur Institutes are found in every

chief city and treatments are given in wholesale numbers.

6. *Intestinal Protozoa of Man:* The principles of control have been covered under helminth control and do not need repetition.

III. ARTHROPODS AND ECTO-PARASITES: In this third heterogeneous group of animal parasites are included many familiar pests and strange histories. To some extent the principles of control we have reviewed come into account, but there is much more departure from rule in this group and greater diversity and originality in the parasite's relations to the human host. A brief note, following Ewing's text, on some of these ecto-parasites is all that time will allow.

1. *Mites* (*Acarina*): Of these there are enormous numbers of very small animals. Several million individuals may occupy a few cubic inches. They are found from northern Greenland to the Antarctic. Each group has been derived apparently from a different type of free-living ancestor. The common habit of parasitism has brought frequently similar adaptations of structure and physiology which give different racial groups a close superficial resemblance. They attack land and aquatic hosts, both vertebrate and invertebrate. Every small rodent is apt to harbor several species. Because of their range and intensity of parasitism, it is believed that parasitic species far outnumber free-living forms. In species they may even outnumber the insects. Some mites are very old in parasitism and the morphologic adaptations are profound. Such differences mark off, for example, the itch mites and the ticks.

The reasons for such frequent parasitism in the mites are to be found in their minute size, enormous abundance, wide distribution and great variety of habits in the free-living forms. Nascent parasitism is seen now in certain living forms as in *Pediculoides*, where a single species may be either a predator, a parasite or a scavenger. It may be one or all three with equal facility depending on the hazards of environment.

2. *The Ticks* (*Ixodidae*): These are a small group, numbering less than 300 species altogether. In number of individuals this is one of the largest and most important groups of all ecto-parasites. They originated from mites and even now the two groups show many structural similarities. *Spelaeorhyncus praecursor* on bats is an excellent example of an intergrade between mites and ticks and may be classified with either. They are important disease carriers, as of spotted fever, and protection against them even yet is chiefly mechanical.

3. *Biting Lice* (*Mallophaga*): These spend their entire life on the host, laying eggs on feathers or hair. They feed chiefly on the barbules of feathers, on epidermal scales and oily secretions of the skin, but at times blood is found in them. They are closely related to the sucking lice. They are characteristic on Australian marsupials, are common on nearly all birds, and are conspicuously absent from several large mammalian groups. The most ancient group of land birds (Galliformes) have the most generalized types of lice which are almost identical with those of the Australian marsupials. The marsupials probably were infected from birds, just as the domestic dog of North America got one louse (*Heterodoxus longitarsus*) from Australian marsupials.

4. *Sucking Lice* (*Anoplura*): This is one of the smallest insect orders with less than 200 species, and is confined to mammals. One family (*Haemato mysidae*) has one species only, and this is found only on elephants. Marsupials, bats and a few other groups have no sucking lice. Blood is almost the exclusive diet of the *Anoplura*. They are therefore important disease carriers, especially in relapsing fever, the typhus fevers and trench fever. Their origin is an unsolved mystery. Their mouth parts resemble those of the true bugs (*Hemiptera*). Their control lies in individual treatment primarily, with disinfection of clothing, personal cleanliness and good housing.

5. *Fleas* (*Siphonaptera*): Fleas are of perennial and especially autumnal interest in California. They are small, laterally compressed insects which are not closely related to any other order. They resemble biting lice in being found on birds and mammals. They are so highly specialized that they can not be traced back to their origin. They constitute an order of remarkable unity and can be divided into families with only partial success. The ordinary human flea is common in Europe, in parts of the Mississippi Valley and especially in California. Their life history is full of interest and their relation to plague transmission is a specialty in itself. While most genera have a favorite host they do not hesitate to bite another host. The rat flea (*Ceratophilus*) dislikes to bite men and the mouse flea does not bite man. *Ctenocephalus* of dogs and cats is not a plague carrier as it rarely bites rodents. The biologic situation in connection with plague is exceedingly complex and far from perfectly understood.

A small group of highly specialized and abnormal fleas is named chigger, jigger, chigoe or sand flea. Those which invade man are called *Tunga penetrans* or *Dermatophilus*. The female burrows under the skin, forms a cyst and lays a huge mass of eggs. Local irritation and secondary bacterial infection are

often serious. It originated in South America but has been carried widely around the world. It attacks many animals, but especially, like *Pulex irritans,* in addition to man it loves the pig. Many biting insects for some strange reason associate man and the pig as hosts, possibly, however, because both have hairless bodies.

Flea control again leaves us dependent primarily on personal cleanliness of living quarters of dogs and cats, with the use of mechanical protection, including more or less effective insecticides. Flea eggs are laid on floors, in nests, dust and refuse and here they pupate. Sanitary cleanliness goes far to reducing the mass attack on man. Here, as in the case of many other animal parasites, there is need of investigation for sub-parasites to destroy the parasites. Excellent work has been done in adapting certain parasitic hymenoptera to this function and the subject is full of promise.

6. *Myiasis* is a condition in which certain fly eggs are laid in wounds or natural cavities of the body, leading to tissue invasion by the maggots and a frightfully severe course clinically. Protection against flies of these types is always important, and local treatment and removal must never be delayed.

CONCLUSION

We have reviewed in summary fashion the general field of the animal parasites of man, emphasizing the factors of origin and evolution on which adequate control must be based. We have seen how fragmentary is our knowledge and therefore how difficult effective control is under present conditions. Parasitism deserves a much more prominent place in general biology and in medical education. Research fields in urgent need of cultivation are along the following lines: (1) Study of natural enemies of parasites. (2) Economic methods of control of sanitary food supply and water provision. (3) Methods of protection of potential intermediate hosts and vectors, as well as soil and water, against infection. (4) Methods of public health control based on epidemiology and biology. (5) Development of new specific remedies. (6) Better conservancy methods in rural, tropical and oriental districts. (7) Popular education, not in parasitology, but in health preservation by avoidance of specific hazards.

Our review has been in general terms. No field, however, offers greater fascination and promise for the student and the research worker. The sociologist and economist also might well devote serious study to parasite and disease control in the world as a whole, because the irrepressible tide of nationalism all over the world is rejecting foreign ideals and ideas along with foreign domination. And in the tropical and oriental countries which contain most of the world's population, a sanitary sense is distinctly a foreign ideal.

NOTE: The texts of Hegner, Faust and Ewing have been drawn on freely in order to build up a general picture of animal parasitism. The purpose has not been to present original work or ideas but to furnish a survey of the field, and to orient the student and technician. For this reason, annotations have been largely eliminated and the authors noted, as well as others mentioned in the text, have been quoted extensively. See Hegner and Andrews, "Problems and Methods of Research in Protozoology"; Hegner, Root and Augustine, "Animal Parasitology"; Ewing, "Manual of External Parasites"; Faust, "Human Helminthology"; Reed, "Tropical Diseases in the United States."

OBITUARY

GEORGE McLANE WOOD

GEORGE MCLANE WOOD, formerly editor of the United States Geological Survey, died in Washington October 26, in his eighty-first year. Mr. Wood was born in Cumberland, Maryland, but spent most of his long and useful life in Washington. He was the son of Colonel William P. Wood, who was superintendent of the Old Capitol Prison during the Civil War and organizer of the United States Secret Service. One of his brothers was the late Samuel A. Wood, for many years the well-known shipping reporter on the New York *Sun.* Mr. Wood had a public school education, but beyond that the knowledge that served him so well was self-acquired. He was an eager student to the end of his life, delving into many subjects that appealed to him—geology in all its branches, languages, philosophy, botany, and particularly the art of expression in clear, terse, forceful English. Beginning at about his eighteenth year, he did stenographic work for private concerns and the government and was regarded as one of the best and most accurate shorthand writers in the city. For a few years he was secretary to the Chesapeake and Potomac Telephone Company. His life work, however, was done in the United States Geological Survey, of which he was a member for nearly forty years.

In his stenographic work he had already developed

a facility for smoothing out crude English, and this was discovered more or less accidentally by Professor Thomas C. Chamberlin, for whom he was writing manuscript from dictation. Mr. Chamberlin, having had a sample of the help he could give, called for more and spread the word among his colleagues. This probably gave the eventual turn to Mr. Wood's career, for it led to his appointment in the Geological Survey. He served as editorial clerk, assistant editor, and finally editor, the position he held from 1908 till his retirement in 1925. During this long period he taught the scientific writers whose work he criticized to welcome rather than resent his criticism, for they learned that it was neither pedantic nor arbitrary but was based on common sense and an earnest desire to be helpful.

The reports of the United States Geological Survey have a wide reputation for lucid, virile, straightforward expression, which is due in large part to the sincere and painstaking efforts of Mr. Wood. His greatest influence was probably exerted by the modest pamphlet in which he put his counsels into print—"Suggestions to authors of papers submitted for publication by the United States Geological Survey." This pamphlet was first published in 1909 and was revised and enlarged in 1913 and again in 1916. It was of course prepared primarily for authors of geologic reports, but its usefulness in other fields was soon demonstrated. Its 50 pages of "suggestions as to expression" have been found to apply so well to scientific and technical writing in general—indeed, to writing of any kind—that the demand for this pamphlet has been wide-spread and continuous, and instead of its long title it is generally known as "Suggestions to authors." The edition of 1916 has been reprinted seven times—the latest printing in July, 1930—and has been sent on request to government and state departments and bureaus, universities and colleges, research and engineering institutions, business executives, and countless individuals engaged in writing. It has also been highly commended by such eminent critics as Brander Matthews in America and Sir Clifford Allbutt in England.

It had been Mr. Wood's hope, after his retirement from the government service, to expand the "Suggestions" into a more comprehensive manual on technical writing. Such a project had been urged upon him by Director George Otis Smith, of the Geological Survey, and many others, and he saw clearly the widened usefulness that would be given to his condensed advice by more detailed elucidation. He had accumulated some material for this purpose, but when it became known that his services were still available he received so many requests for help that they left him no time for his own work. He was at the beck and call of any one who needed him and, though more than 75 years old, put in longer hours than he had in his official life. The larger part of this work was done in geology and allied fields. His last work for the Geological Survey was done on Henry Fairfield Osborn's monograph on the titanotheres, and Professor Osborn made arrangements for him to continue that work for the American Museum of Natural History after his retirement from government service. He prepared many of the articles on the geology of North and South America in the new edition of the Encyclopaedia Britannica. The recently published symposium "Creation by evolution" owes in no small degree the clarity and force of its articles to his skillful editing, though he preferred to remain anonymous on that work. At the time of his death he was editorial reader for the *Bulletin* of the Geological Society of America and the Arkansas Geological Survey, and one of his latest tasks was to edit a memoir on the geology of Cape Cod for the Harvard Museum of Comparative Zoology. He died practically "in harness," having been ill only three days.

No one could have been in intimate daily contact with George McLane Wood during the last twenty years of his service for the United States Geological Survey without learning to appreciate the spirit that animated him. It was a privilege to work under him, and I am honored in being permitted to pay this tribute to his memory. He scorned hypocrisy and bluff but could not do too much for any one who was earnestly endeavoring to increase the sum of human knowledge. His kindliness was a subject of common remark—he was as considerate of the humble messenger boy as of his chief. His sense of humor was keen and enabled him to take the bumps of life with a twinkle in his eye. His characteristics were well summed up by Professor Harlow Shapley, of Harvard University, who said at the funeral service that he exemplified the four things that justify the experiment of living—sincerity, enthusiasm, skill and usefulness.

BERNARD H. LANE
UNITED STATES GEOLOGICAL SURVEY

MEMORIALS

THE college of forestry of Syracuse University recently unveiled a portrait of the late Dean Franklin Moon in the faculty room of the college. Dean Moon had been connected with the College of Forestry since its beginning in 1912.

As a memorial to Francis P. Leavenworth (1858–1928), professor of astronomy at the University of Minnesota from 1897 to 1927, the University of Min-

nesota Press is publishing his "Measures of Double Stars," left at the time of his death. The book includes a number of measurements made by William O. Beal, who was assistant professor of astronomy at the University of Minnesota from 1913 until his death in February, 1930. The records in the book were made during a period of forty years, and consist of the measures of 1,185 stars. Both Mr. Leavenworth and Mr. Beal were members of Sigma Xi and of the American Astronomical Society.

AT the same time that Admiral Richard E. Byrd received the Langley Memorial Medal, America's highest award for achievement in the field of aeronautics, a similar honor was conferred posthumously on Charles Matthews Manly in recognition of his pioneering work in connection with the first aeroplane flight in this country. Charles W. Manly, a Cornell undergraduate, accepted this award on behalf of his father. The exercises took place at the Smithsonian Institution in Washington during the annual meeting of the Board of Regents on December 11. Chief Justice Charles E. Hughes made the presentation address. The Langley Medal has been awarded only five times previously—to the Wright brothers, Eiffel, Curtiss and Lindbergh. The medal is cut from a die kept in the French mint in Paris. The belated honor to Charles M. Manly comes as a result of the suggestion of Mr. Charles L. Lawrance, president of the Wright Aeronautical Corporation. On his graduation from Cornell in 1898, Charles Matthews Manly went to Washington as chief assistant to Samuel P. Langley and was engaged in aviation development at the Smithsonian Institution until 1905. He built and piloted the historic Langley aeroplane in its tests in 1903, when the work was stopped by lack of funds from congressional appropriations.

RECENT DEATHS

DR. M. A. MINER, until his retirement in 1916 professor of chemistry and pharmacology in Northwestern University, died on December 11 at the age of eighty-one years.

PROFESSOR ALBERT DICKENS, head of the department of horticulture of the Kansas State College at Manhattan since 1902, died on November 28 at the age of sixty-two years.

THE following deaths are reported in *Nature:* Dr. J. W. Evans, C.B.E., F.R.S., a past president of the Geological Society, on November 16, aged seventy-three years; Dr. E. R. Frazer, a distinguished pathologist and benefactor of the University of Oxford, on November 17, aged sixty-three years; Dr. G. H. K. Macalister, formerly principal of the Singapore Medical College and editor of the *Malaya Medical Journal*, on November 2, aged fifty-one years; Dame Mary Scharlieb, a pioneer in medical education for women, on November 21, aged eighty-five years; Professor J. H. Teacher, St. Mungo (Notman) professor of pathology at Glasgow University, on November 21, aged sixty-one years.

SIR FRANCIS OGILVIE, former director of the National Science Museum at South Kensington, died in Edinburgh on December 14 at the age of seventy-two years.

SCIENTIFIC EVENTS

ARCHEOLOGICAL FIELD WORK OF THE UNIVERSITY OF MINNESOTA IN 1930

DR. ALBERT ERNEST JENKS, professor of anthropology, University of Minnesota, has returned to Minneapolis after an absence of eight months in archeological field work in North Africa and Europe. Accompanied by Mrs. Jenks and two graduate students, Lloyd A. Wilford and Ralph Brown, Dr. Jenks, in cooperation with Logan Museum, dug shell-heap culture during the three spring months on the high plateau of central Africa.

The Minnesota party spent June in reconnaissance farther south in the barren deserts of Algeria and Tunisia. It located eleven unrecorded shell-heaps, found habitation grottoes and rock shelters in two areas never studied, and in its excavations had particularly good fortune. About 6,000 pieces of flint from the one shell-heap trenched were brought back, while an equal number were left with the Algerian government. The party also found seven human burials in undisturbed position which are of the age of the shell-heap at its mid-development. This skeletal material becomes particularly valuable in America, since the University of Minnesota purchased from M. Arthur Debruge, of Constantine, the type-skull of the shell-heap culture of North Africa, the "Mechta el Arbi" man, found by Debruge in 1912 and first measured and published in 1923–1924 by M. Henri Logotala.

Though the prehistoric stone culture of North Africa was named "Capsian" from the Latin name of the present Tunisian oasis of Gafsa, and again named "Getulian" (a pre-Roman local tribal designation), yet the vast amount of the artifacts assembled for the scientific study of that culture came from the provenence around about Redeyef—a desert phos-

phate mining camp some forty air-line miles west of Gafsa. That area lies in the once well-watered triangle of some twenty-five kilometers along its base on the Southern border fixed by the three barren mountains, Bliji, Chouabine and Alima, with Redeyef close to that base line near its middle. Professor Jenks was fortunately able to purchase the collection of M. Louis Gaillot, of Redeyef, gathered over a period of twenty-five years, which played an important part in M. Gobert's studies of that North African culture ranging well throughout the time and type of the Aurignacian stage of culture in Europe. That collection, together with the entire Debruge collection of artifacts, of animal bones, and of seven human crania—including the Mechta el Arbi type-skull, and the abundant materials resulting from Minnesota digging and surface find far afield in 1930—enable the University of Minnesota to contribute an important part to the ever-growing source-material of prehistory available for students in America.

July and August were spent digging in France and Czecho-Slovakia. In France, Professor Jenks was with Dr. Henri Martin at his famous Mousterian site at La Quina and there dug and from there brought back an extensive and excellent collection of flint and bone implements and more than 100 pieces of animal bone which show the marks of the flint tools of Neanderthal man. The time spent in Czecho-Slovakia was largely in the nature of a reconnaissance, but fruitful digging was done as arranged by the Zemska Museum of Brno. In the vicinity of Znojmo, Neolithic-age, Bronze-age and Hallstad-iron age sites were dug and small amounts of typical cultural materials were thus secured and exported. Besides a considerable collection of identified prehistoric materials were purchased in Moravia.

Mr. Wilford, assistant to Professor Jenks, returned to the University of Minnesota the middle of June. During the summer he continued archeological work at the Minnesota Mimbres site on the Galaz ranch in southwestern New Mexico. A small amount of excavation was also undertaken in the Upper Gila culture (bordering the Mimbres on the north) and in the Chihuahua culture (bordering Mimbres on the south.)

The archeological program at the University of Minnesota is made possible over a term of years through the gift of money by interested citizens of Minneapolis. The Minneapolis Institute of Arts, as well as the University of Minnesota, shares in the materials acquired by research and purchase.

WORK OF THE SMITHSONIAN INSTITUTION

IN his annual report presented to the regents of the Smithsonian Institution, Secretary Charles G. Abbot lists a number of important achievements in the "increase of knowledge" and one material event which is certain to make possible a greater number of such achievements in future years.

That event is the authorization by Congress of an appropriation to add wings to the natural history building of the National Museum at a cost of $6,500,000. This will mean, besides increased exhibition space, many new laboratories for the preservation and study of the collections.

Of the achievements reported by Dr. Abbot is the discovery by the Astrophysical Observatory of an apparently considerable influence of short period solar variation on the temperature of the United States. That is, an average change of 0.8 per cent. in the sun appears to cause a temperature change of the order of 5° Fahrenheit in Washington. "Although this relation is complicated," says Dr. Abbot, "it offers promise of weather forecasting nearly a week in advance."

The institution's new division of radiation and organisms has made rapid progress in the construction of laboratories for physical, chemical and biological investigations. In an experiment on the amount of bending of plants towards light of various wave lengths, it was found that red or infra-red light produced no bending of the plant; that yellow light produced a small bending; that green light was one thousand times more effective than yellow; and that blue light was thirty thousand times more effective than yellow.

During the year the Smithsonian brought to a conclusion its support, which has lasted twelve years, of Dr. R. H. Goddard's experiments in designing and building a rocket to explore the unknown upper layers of the atmosphere.

Dr. Goddard's experiments are now going on in New Mexico under a gift from the late Simon Guggenheim. "It is a pleasure to record here," says the report, "that the Smithsonian has again been able to support during its more or less uncertain pioneering stages an investigation of great promise for the increase of knowledge."

In the natural sciences twenty-eight major expeditions were sent out during the year to widely scattered regions. These included expeditions to remote Eskimo and Indian tribes in Alaska by Dr. Aleš Hrdlička and Mr. Henry B. Collins, Jr.; an extended botanical exploring trip along the Amazon in Peru and Brazil by Mr. Ellsworth P. Killip; intensive collecting of mollusks in the West Indies by Dr. Paul Bartsch; as well as anthropological, biological and geological expeditions to Africa, Spain, the Philippines, China, Siam, and many parts of this continent.

The Bureau of American Ethnology excavated Indian sites in Florida and Arizona, carried on field

work among the Choctaws of Mississippi and the Creeks of Oklahoma, the San Juan tribe of California and the Iroquois of New York State and Canada. Indian music of ten different tribes was collected and much work was done in the preparation of dictionaries and grammars of various Indian languages.

The National Zoological Park during the year began the construction of a new reptile house authorized by Congress. This will permit the National Zoological Park to exhibit for the first time an adequate representation of the cold-blooded vertebrates. The collection at the close of the year numbered 2,000 animals including several species not shown in any other American zoo.

The National Gallery of Art held many exhibits during the year including one of the seventy-eight American paintings purchased during the last ten years from the Ranger fund. The Freer Gallery of Art has added a valuable variety of objects of art from countries stretching from Egypt to China.

The International Exchange Service continues its task of distributing governmental, scientific and literary publications from this country to governments and learned societies abroad, and from abroad to learned societies in this country.

THE COMMITTEE OF ONE HUNDRED AT CLEVELAND

A GENERAL meeting of the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science will be held at the Cleveland meeting to listen to reports of committees and to consider the future course of its work. The committee has concerned itself, among other things, with the conditions of the researcher as influential in the progress of research and has found in the economic status of the researcher one important condition. One suggestion for the future work of the committee proposes the careful study of a large number of American colleges and universities from these standpoints: salary adequacy, opportunity for and policy toward supplementary earnings, adequate provision for retirement, teaching load, support of research through financial support or through systematic time grants. With the information thus gained, it is suggested that institutions might be grouped into classes representing different grades of policy and of accomplishment. Such a survey would bring out institutions having promise for able researchers and those having less.

This discussion is likely to be very interesting and important. The committee will meet in the Statler Hotel at 2:30 P. M. on Tuesday, December 30.

RODNEY H. TRUE,
Secretary, Committee of One Hundred

STATISTICS OF UNIVERSITY REGISTRATION

ATTENDANCE at American colleges and universities showed an upward trend this year. The annual study of Raymond Walters, dean of Swarthmore College, published in the issue of *School and Society* for December 13, shows that the trend exceeded that of the last several years and approached the precentage increase of the post-war period.

Reports from 431 institutions of all types in every state in the Union show totals for November 1 of 578,111 full-time students, an increase of 3½ per cent. over the full-time totals on November 1, 1929. The grand total attendance, including part-time students and the summer session of 1930, is 871,184.

For full-time students the order is presented by Dean Walters as follows:

California (including the university at Berkeley and at Los Angeles), 17,322; Columbia, 14,958; Illinois, 12,709; Minnesota, 12,490; New York University, 12,147; Ohio State, 10,709; Michigan, 9,431; Wisconsin, 9,401; Harvard, 8,446; University of Washington (Seattle), 7,368; University of Pennsylvania, 7,252; Pittsburgh, 7,098; Northwestern, 6,184; Texas, 5,970; Nebraska, 5,795; Cornell, 5,725; Chicago, 5,679; Boston University, 5,606; College of the City of New York, 5,312; Yale, 5,259; Oklahoma, 5,210; University of Iowa, 4,860; Temple University, 4,736; Hunter College, 4,614; Cincinnati, 4,537.

Ranked as to grand totals, including part-time and summer students, three New York City institutions lead and another stands sixth. The grand total follows:

Columbia, 33,144; New York University, 29,214; College of the City of New York, 24,752; California, 22,797; Minnesota, 18,505; Hunter, 15,447; Illinois, 14,169; Northwestern, 14,152; Pennsylvania, 13,828; Ohio State, 13,730; University of Southern California, 13,627; Pittsburgh, 13,515; Boston, 12,713; Western Reserve, 12,450; Chicago, 11,757; Michigan, 11,756; Cincinnati, 11,454; Harvard, 10,855; Wisconsin, 10,668; University of Washington (Seattle), 10,197; College of the City of Detroit, 9,342; Texas, 9,203; Nebraska, 8,993; Temple, 8,992; Fordham University, 8,781.

The nine largest liberal arts enrolments are:

California, 9,969; New York University, 5,480; Minnesota, 4,618; Michigan, 4,214; College of the City of New York, 3,884; Illinois, 3,800; Columbia, 3,450; Harvard, 3,239; Texas, 3,184.

Among medical schools those having the largest enrolment are:

Northwestern, 740; Pennsylvania, 663; Minnesota, 659; Illinois, 576; Michigan, 573; Chicago, 546; Harvard, 517; Indiana, 439; Columbia, 430; Ohio State, 343.

SCIENTIFIC NOTES AND NEWS

PROFESSOR ALBERT EINSTEIN arrived in New York on the steamship *Belgenland* on December 11 and proceeded by way of Panama to Pasadena on December 15. Dr. Einstein was officially welcomed at the City Hall by Mayor Walker, the address of introduction being made by Dr. Nicholas Murray Butler, president of Columbia University.

THE Nobel prizes in science were awarded in Stockholm on December 11, when addresses were made by the recipients, Dr. Karl Landsteiner, of the Rockefeller Institute for Medical Research, in medicine; Sir Chandrasekhar Venkataram Raman, of the University of Calcutta, in physics, and Professor Hans Fischer, of the University of Munich, in chemistry.

FOR their work on pernicious anemia Dr. George H. Whipple, of the University of Rochester, and Dr. George R. Minot, of the Harvard Medical School, are the joint recipients of the *Popular Science Monthly's* first annual award of $10,000 "for the current achievement in science of the greatest benefit to the public." The awards and gold medals were presented on December 18, at a dinner at the University Club, New York, at which the principal address was made by Dr. Robert A. Millikan.

THE Edison Medal for 1930 has been conferred by the American Institute of Electrical Engineers on Dr. Frank Conrad, assistant chief engineer of the Westinghouse Electric and Mfg. Company, with which he has been associated for forty years.

DR. WILLIAM H. WELCH on December 12 was reelected president of the Johns Hopkins University Club for his sixteenth term.

DR. WILLIAM ALBERT SETCHELL, professor of botany, has been chosen as faculty research lecturer at the University of California for 1931. The choice was made by the academic senate on the unanimous recommendation of the committee on the faculty research lecture, consisting of the men who have had this honor in previous years. The lecture is to be given on the evening of March 24. Professor Setchell has been at the University of California for thirty-five years in his present position.

Nature extends congratulations to three fellows of the Royal Society, all of them distinguished by long and notable scientific activity, who celebrated birthdays during the last week of November. They are: Professor J. Cossar Ewart, a graduate and formerly Regius professor of natural history of the University of Edinburgh, who, on November 26, entered on his eightieth year; Professor Horace Lamb, a graduate of Trinity College, Cambridge, and formerly professor of mathematics in the University of Manchester, who, on November 27, reached the age of eighty-one years, and Sir J. Crichton-Browne, a graduate of Edinburgh, past president of the Medical Society of London, the Neurological Society and the Medico-Psychological Association, and for many years treasurer of the Royal Institution, who attained the age of ninety years on November 28.

WHILE in England recently as an official delegate to the World's Veterinary and World's Poultry Congresses, Dr. John R. Mohler, chief of the Bureau of Animal Industry of the U. S. Department of Agriculture, received an honorary veterinary degree from the Royal College of Veterinary Surgeons. In addition he was awarded the diploma of corresponding honorary member of the section of comparative medicine by the Royal Society of Medicine of Great Britain. The Hungarian Veterinary Medical Association at Budapest elected him a corresponding member.

PROFESSOR J. W. BEWS, professor of botany at the Natal University College, Pietermaritzburg, has been elected president of the South African Association for the Advancement of Science. The next annual meeting of the association will be held in July, 1931, at Grahamstown.

THE nominating ballots for president sent out by the American Chemical Society have resulted in the nomination of four members, one of whom will be chosen by the council as president-elect in 1931. These are Dr. Joel Henry Hildebrand, professor of chemistry in the University of California; Dr. S. C. Lind, director of the school of chemistry at the University of Minnesota; Dr. L. V. Redman, vice-president and director of research of the Bakelite Company, and Dr. Hugh Stott Taylor, professor of physical chemistry at Princeton University.

PROFESSOR JOHN C. OLSEN, head of the department of chemistry and chemical engineering at the Polytechnic Institute of Brooklyn, was elected president of the American Institute of Chemical Engineers at the twenty-third annual meeting held at New Orleans on December 8, 9 and 10.

THE Association of Consulting Chemists and Chemical Engineers, at the recent annual meeting, elected the following new officers: *President,* Allen Rogers; *Vice-president,* Robert Schwarz; *Treasurer,* Alvin C. Purdy; *Secretary,* Paul Mahler.

MR. BANCROFT GHERARDI, vice-president and chief engineer of the American Telephone and Telegraph Company, was elected to the presidency of the American Standards Association at the annual meeting of the association at the Hotel Astor, New York, on December 11. Cloyd M. Chapman, engineer, of New York City, was reelected to the vice-presidency.

DR. CHARLES EDWARD SKINNER, assistant director of engineering in the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania, has been nominated for the presidency of the American Institute of Electrical Engineers for the term beginning on August 1. The other nominations were, vice-presidents, W. B. Kouwenhoven, professor of electrical engineering in Johns Hopkins University; Professor W. E. Freeman, of the University of Kentucky; Paul H. Patton, of the Northwestern Bell Telephone Company, Omaha, Neb.; A. W. Copley, of the Westinghouse Electric and Manufacturing Company, San Francisco; L. B. Chubbuck, of the Canadian Westinghouse Company, Ltd., Hamilton, Ont.; treasurer, W. I. Slichter, of Columbia University. Those named for the directorate were: L. W. Chubb, of the Westinghouse Company in East Pittsburgh; B. D. Hull, of the Southwestern Bell Telephone Company, of Dallas, Tex.; H. R. Woodrow, of the Brooklyn Edison Company, Inc.

PROFESSOR ARTHUR E. HILL, of New York University, has been elected chairman of the New York Section of the American Chemical Society for 1931. He succeeds Dr. J. G. Davidson, of the Carbide and Carbon Chemicals Corporation. Dr. Davidson was named to the executive committee, other members of which are: J. G. Detwiler, consulting chemical engineer, The Texas Company; Professor R. R. Renshaw, New York University, and Dr. Foster D. Snell, consulting chemist, Brooklyn. Councillors were elected as follows: Dr. Benjamin T. Brooks, consulting chemist; Miss Marie Farnsworth, instructor in Washington Square College, New York University; Dr. Martin H. Ittner, chief chemist of the Colgate-Palmolive-Peet Company, Jersey City; Professor Daniel D. Jackson, head of the department of chemical engineering in Columbia University; Professor Arthur W. Thomas, Columbia University; D. H. Killeffer, chemical engineer of the Dry Ice Equipment Corporation; Professor Herbert R. Moody, College of the City of New York; Professor John C. Olsen, head of the department of chemical engineering of Brooklyn Polytechnic Institute; Professor Allen Rogers, Pratt Institute, Brooklyn; Sidney D. Kirkpatrick, editor of *Chemical and Metallurgical Engineering;* James W. H. Randall, consulting chemical engineer; C. R. De Long, research chemist of the Mutuelle Solvay of America, Inc.; Professor Hans T. Clarke, College of Physicians and Surgeons, Columbia University; Stephen L. Tyler, chemical engineer, The Thermal Syndicate, Ltd., Brooklyn; Frank E. Barrows, patent attorney of Pennie, Davis, Marvin and Edmonds; Charles T. Whittier, research chemist of the Royal Baking Powder Company.

As a result of the elections recently held, the personnel of the council of the Canadian Phytopathological Society for the year 1931 will be as follows: *President,* W. P. Fraser, University of Saskatchewan; *Vice-president,* D. L. Bailey, University of Toronto; *Secretary-treasurer,* T. G. Major, Tobacco Division, C. E. F., Ottawa; *Councillors,* H. T. Güssow, Division of Botany, C. E. F., Ottawa; G. H. Berkeley, Dominion Laboratory of Plant Pathology, St. Catherine's.

DR. HENRY BRYANT BIGELOW, of the Harvard University Museum of Comparative Zoology and director of the Oceanographical Institute at Woods Hole, has been appointed professor of zoology in the university. Dr. Charles Galloupe Mixter has been appointed assistant professor of surgery.

A SEPARATE department of radiology will be established in the College of Medicine of Syracuse University as the result of a grant from the Chemical Foundation. Dr. Donald C. Childs as professor of clinical radiology and Dr. Aden J. King as professor of radiological research will supervise the work in this department.

DR. C. H. CRICKMAY, assistant professor of geology at the University of California at Los Angeles, has been appointed assistant professor of geology at the University of Illinois. His term of service is to begin on February 1.

DR. C. E. LEIGHTY, formerly principal agronomist in charge of eastern wheat investigations in the office of cereal crops and diseases of the Bureau of Plant Industry, has been designated principal agronomist in charge of the office of dry-land agriculture, to fill the vacancy caused by the death of Dr. Chilcott.

MR. W. V. A. KEMP, former director of research of the committee on heat transmission of the National Research Council, and more recently research secretary of the National Electric Light Association, has resigned in order to travel abroad. Mr. Kemp will study certain engineering developments in other countries and will return to the United States in about a year.

DR. C. E. MCCLUNG has returned from South America, where he represented by invitation the biologists of the United States at the International Congress of Biology held in Montevideo, Uruguay,

from October 8 to 12. He also gave lectures and demonstrations before the faculty of medicine of the University of Buenos Aires.

DR. DOW V. BAXTER, of the School of Forestry of the University of Michigan, who recently returned from Europe, is preparing to publish the results of his study of the Dutch elm tree disease. While in Europe during the past summer Professor Baxter investigated methods being used by other governments to combat this disease.

DR. THOMAS S. BAKER, president of the Carnegie Institute of Technology, Pittsburgh, is visiting Europe in the interest of organizing the third international conference on bituminous coal. He will extend invitations to well-known fuel technologists in the principal cities of Europe to attend in Pittsburgh the third congress on coal which will be held in November, 1931. Dr. Baker plans a stay of two months during which he will visit Paris, London, Berlin, Brussels and other European capitals.

DR. P. J. HANZLIK, professor of pharmacology in the Stanford University School of Medicine, San Francisco, will give a series of lectures in Southern California from December 16 to 19. The series will include lectures on bismuth compounds in antisyphilitic therapy, metallotherapy of edema, intravenous therapy, and colloidal dyes in intoxications before the San Diego Academy of Medicine, Long Beach Academy of Medicine and Galen Club and Los Angeles Hewlett Club.

MR. PHILIP H. GADSDEN gave the first lecture in the eighth series of Aldred Lectures at the Massachusetts Institute of Technology on December 5. He spoke on "The Engineer's Responsibility to Society." Mr. Gadsden is vice-president of The United Gas Improvement Company and president of the Philadelphia Chamber of Commerce.

PROFESSOR H. T. TIZARD, rector of the Imperial College of Science, South Kensington, lectured at King's College, London, on November 26 on "Scientific Industry as a Career."

SWAMPSCOTT, Massachusetts, has been selected as the place of meeting of the American Institute of Chemical Engineers in June, 1931. The meeting of 1932 will be held in England, the city to be determined later.

THE jury of award of the International Exposition at Liége has issued to the American Chemical Society a certificate showing that a diploma of honor has been awarded to the society for its journals which were exhibited at the exposition.

PLANS are being prepared for the new laboratory building of the Scripps Institute of Oceanography which will be built at a cost of $120,000. The funds are provided by state appropriation, by gift from the Rockefeller Foundation and by donation from the Scripps family in equal amounts. The preliminary plans call for laboratories dedicated to dynamical oceanography and marine meteorology, chemistry, marine bacteriology and the physiology of marine organisms.

DEEDS to the million-dollar estate at Huntington, Long Island, of Mrs. W. J. Conners, widow of W. J. Conners, publisher, of Buffalo, were presented on December 10 by Mrs. Conners to Dr. Reginald Knight Smith, president of the Better Health Foundation of California. Under the auspices of the Better Health Foundation of New York, a branch of the California organization, the estate will be devoted to cancer research on the lines followed by Drs. Walter B. Coffey and John D. Humber of San Francisco. Herbert L. Satterlee, of the law firm of Satterlee and Canfield, will be chairman of the executive and finance committees of the New York organization.

THE U. S. Naval Observatory has issued an announcement in regard to the recent eclipse expedition, according to which three members of the United States Naval Observatory eclipse expedition who observed the total eclipse of the sun on October 21, on Niuafou Island, Tonga Archipelago, have returned to Washington with 72 photographic plates taken with the seven cameras varying from 38 inches to 65 feet in focal lengths, which were a part of the equipment used to photograph this most interesting phenomena. Commander C. H. J. Keppler, United States Navy, officer in charge of the expedition, together with Lieut. H. C. Kellers, Medical Corps, United States Navy, and Mr. Bevan Sharpless, junior assistant, carried these plates as personal baggage, in order to ensure their safe arrival at the observatory. About twenty other plates, including those to be used in a further study of the Einstein effect, are being returned to Swarthmore College by Professor R. W. Marriott, while Professor S. A. Mitchell, of the University of Virginia, is bringing 18 films taken with the powerful convex gratings of the two spectrographs. Motion picture films of the eclipse from three cameras are now being developed in New York. All scientists are extremely gratified over the results achieved, and Professor Mitchell has written to the Superintendent of the Naval Observatory, Capt. Julius F. Hellweg, United States Navy, that, in his opinion, this has been the most successful eclipse expedition ever carried out by the United States Naval Observatory. About 200 boxes of scientific apparatus and expedition equipment were carried from Niuafou Island to Pearl Har-

bor on board the United States ship *Tanager,* and will be returned to Washington *via* Navy transport. During the passage of the *Tanager* from Niuafou to Tutuila, a heavy gale was encountered and the *Tanager* was compelled to lie to for 18 hours in order to insure the safety of the eclipse records and equipment. Maximum rolls of 48 degrees to a side were recorded during the height of the gale.

THE Hydrographic Office of the Navy celebrated on December 6 a century of assistance in making navigation of the sea safe throughout the world. As a part of the program Secretary Adams delivered an address which was broadcast by radio on the history and work of the office. The centennial marks the progress made from the time the office was established under Lieutenant L. M. Goldsborough as a "depot of charts and instruments," with a working force of two officers and one nautical expert. It now has a working force of eleven officers and 180 civilians and nineteen branch offices in the continental United States in charge of twenty officers and twenty-four civilians. The office has 300,000 charts and 100,000 manuals and books ready for issue. On its correspondence list are 7,000 mariners and aviators of all nationalities. It receives information from naval vessels, American consuls, scientific organizations and foreign governments, and exchanges information with the hydrographic offices of other navies. The office also sends out by naval radio broadcast information received from the ice patrol, merchant vessels and other sources concerning dangers to navigation; conducts hydrographic surveys and maintains a section of static research which hopes through experiments to locate the centres of West Indian hurricanes soon after their formation and predict their subsequent path.

DISCUSSION

AN APPEAL FOR THE ISSUANCE OF REPRINTS OF THE TABLES OF CONTENTS OF SCIENTIFIC JOURNALS

IF scientific journals would offer for sale, with each number of the journal, reprints of the table of contents, I believe that the journals would thereby perform a real service to many of their readers and could perhaps make a small profit.

Take as an illustration the journals which are devoted partly or wholly to physics, and consider the use which an American physicist, John Smith, would make of these reprints. John Smith would not care about the reprints offered by the *Physical Review* because as a member of the American Physical Society he receives a personal copy of the *Review,* but he would consider it a distinct service if he could have placed upon his desk a reprint of the table of contents of each number of the *Proceedings of the National Academy,* the *Proceedings of the Royal Society,* the *Zeitschrift für Physik,* etc., when the number appears. Our physicist does not subscribe personally to these journals but he has access to a library which subscribes to all the journals in which he is interested. If the managements of the journals offered to furnish the reprints, John Smith and his colleagues would arrange with the library to subscribe for the desired number of reprints, and they would reimburse the library if necessary for the small outlay involved. The reprints could be sent to the library with the journal itself, thus avoiding extra wrapping and postage. The reprints would be sent only to those libraries subscribing for them say in lots of three, six, nine, etc. A dollar and a half or two dollars per year should provide John Smith with reprints from a half dozen monthly journals. He checks off upon his reprints the articles in which he is interested, and when next he has an hour to spend in the library he knows exactly what new numbers of journals have come in and what he wants to read in them. The reprints, as they accumulate, serve John Smith as a nucleus of his personal reference file. If he desires, he can have a typist transcribe the titles which he has checked to an author index or a subject index. It is far less feasible for a member of a staff to furnish a typist with the journals themselves as copy, as he must do under existing circumstances when he wishes titles transcribed.

In a university the reprints would be of service interdepartmentally. At present a man in one department must go to libraries scattered all over the campus if he wishes to keep up with the publications of some of the learned societies, as for instance those of the Berlin Academy, and with some of the journals in allied fields. But with the reprints available he would first consult the table of contents of the publications in his own library where files of these could be provided at trifling expense.

It takes little imagination to realize that the reprints would render service in several ways not at all rendered by abstract journals, such as *Science Abstracts,* which are always several months behind.

A given journal might conceivably suffer the loss of two or three personal subscriptions through supplying border-line subscribers with an inexpensive method of keeping in touch with its table of contents.

The number of subscriptions so lost would certainly be very small however. The management of a journal could recoup itself for this loss and even make a small profit by charging for the reprints several times the cost of output—and they might still be quite inexpensive.

For the reprints to be of real service to workers in one field of knowledge, most of the leading journals in that field should offer them. This would require something approaching concerted action on the part of the journals and such action will perhaps be difficult to secure.

This appeal is written with the principal object for the present of arousing, if possible, widespread consideration and discussion of the desirability of having the reprints. If, upon consideration, a large proportion of scientific workers come to believe that the reprints would be of service and should be available, then the journals would probably offer them provided the journals were apprized of the generality of this belief. Further discussion of the subject on the part of others than the writer in the columns of SCIENCE or elsewhere would no doubt help in the apprizing. Or, if representatives of departments or laboratories would write, on behalf of the groups which they represent, to the various journals whose reprints they would like to have, this would be a beginning. The journals might be induced by such letters to make inquiry among the libraries on their subscription list to determine approximately the total number of reprints wanted. However, it may develop that the very demand would require cultivation. Is it too much to hope that one or more journals may undertake this cultivation by offering the reprints over a period of years? Be this as it may, I personally feel convinced that the reprints are something we should have; if others who now feel or come to feel likewise, will put forth some small effort which they consider suitable by way of agitating the matter, perhaps we shall some day have them.

CHARLES F. MEYER

DEPARTMENT OF PHYSICS,
UNIVERSITY OF MICHIGAN

MITOCHONDRIAL BEHAVIOR

AN article on "Mitochondrial Behaviour during the Life-cycle of a Sporozoon (Monocystis)" in a recent number (July, 1929) of the *Quarterly Journal of Microscopical Science* suggests several queries. The paper states that material was obtained from "the sperm-sacs of the common Australian (European) earthworm." "Sperm-sacs" presumably refers to those organs which oligochaetologists call seminal vesicles, although the term sperm-sac has also been used for testis-sac or testicular chamber as well as for spermatheca. But what is meant by "the common Australian (European) earthworm"? Again presumably this refers to one of the peregrine Lumbricids that have been imported into Australia and which have become acclimated in settled areas around towns and cities. But which one? At least six species of Lumbricids have been recorded from Australia: *Eiseniella tetraedra, Eisenia foetida, Allolobophora caliginosa, Bimastus parvus, Bimastus constrictus* and *Octolasium lacteum*. These worms when found elsewhere are usually present in considerable numbers, so that to each one of them the adjective common might be applied. Thus an investigator who procures his earthworms from manure piles might regard *E. foetida* as the common species, while another investigator who gets his material from the very same locality but at a distance of a very few feet from the manure piles would probably find another species to be the common form. Similarly, a thick grove or river bank only a short distance from both the preceding places might have still other common species. The phrase "the common earthworm" in such a region must therefore be nearly as meaningless as "the common bird" or "the common fish" would be. It is of course possible that of the earthworms in the vicinity of Melbourne such an overwhelming majority belong to one particular species as to justify use of the words "the common" in referring to it, but no evidence for this has been found in the literature, and even were this the case, outsiders can hardly be expected to know what the common European earthworm of Australia might be.

In this connection may I call attention to a few sentences in Stephenson's "The Oligochaeta" which, because of their situation in the preface, may not receive the consideration to which they are entitled.

> While on the subject of nomenclature, may I suggest, more particularly perhaps to some of the authors who write on physiological subjects (although morphologists are not invariably above suspicion in the matter), that they should identify, or get identified, their material? It is not nowadays sufficient to talk of "the earthworm"; there are 1,800 species. . . . "The common earthworm," too, is meaningless—what is the common earthworm in one part of the country is not so in another; while the specious appearance of exactitude given by the phrase "the common earthworm, *Lumbricus terrestris*," is (at least as a rule) entirely fallacious.

Furthermore, the author of the paper under consideration did not state which one of the species of *Monocystis* that occur in the seminal vesicles of earthworms he studied. The importance of such systematic precautions is made quite evident by the fact that "there may be as many as five different species pres-

ent at the same time, as is the case in the seminal vesicles of *Lumbricus terrestris*."[1]

Of course, the behavior of mitochondria during the life cycle may be exactly similar in all species of *Monocystis*, but this has not yet been proved. In the meantime, until the particular species both of host and parasite investigated by the author be known, his results are invalidated by the possibility of the confusion of several species of *Monocystis*, the behavior of the mitochondria of each of which may be entirely different. As in other cases that might be mentioned, corroboration of the results obtained is impossible because of the anonymity in which the particular animal concerned is shrouded.

G. E. GATES

JUDSON COLLEGE,
RANGOON, BURMA, INDIA

BENTONITE IN THE ORDOVICIAN NEAR COLLINGWOOD, ONTARIO[1]

EXAMINATION of samples from the Robert Cherry No. 1 well on the shore of Lake Huron about 2½ miles southeast of Collingwood, Ontario, showed bentonite in one sample from a depth of 320 feet. The material is light gray, soft, with a greasy feel. In water it expanded considerably and disintegrated rapidly. The residue after panning showed pyrite with biotite flakes up to 0.2 mm with subordinate amounts of zircon, apatite and tourmaline. Dr. C. S. Ross, of the U. S. Geological Survey, confirmed the bentonitic character of the material. He reported that the structure was very similar to that of the Ordovician bentonites found in Tennessee and Virginia, more especially to that found at Catawba, Virginia, that it showed the character of fine-grained pumice and that it was similar in physical properties and in contained biotite grains. An analysis for potash made by the Mines Branch, Department of Mines, Ottawa, Canada, showed 6.08 per cent. K_2O on material dried at 105° C.

The well samples show limestone down to the bentonite bed and for 35 feet below it to the basal sandstone resting on the Precambrian. The driller reported shale at 315 to 327 feet. The sample of bentonite was quite pure. It is possible therefore that the bentonite bed is several feet thick. The well started in the Trenton limestone but below the top of this formation which, together with the underlying Black River limestone, has a thickness at Collingwood of about 550 feet as shown by well records. No fossil evidence was obtained from the samples, and the exact horizon at which the bentonite occurs is not known. It probably occurs in the upper part of the Black River limestone.

D. C. MADDOX

GEOLOGICAL SURVEY, CANADA

THE RELATION OF THE PARANASAL SINUSES TO THE SINGING VOICE

ONE of the problems encountered in the teaching of singing is the determination of the potential range of the voice. It has been a matter for the ear of the teacher to decide, and in many cases the decisions have not been correct.

Many theories have been advanced regarding this phase of vocal work, among them that of laryngeal differences. None of them have proved conclusive to any degree of accuracy.

After some years of experimental research, using the x-ray as the exploring medium, the writer has made several discoveries that seem significant.

First, that the range of the voice seems to be governed by the length of the resonating space in the frontal sinuses. Practically all the cases examined have shown a direct relationship between the range of the voice and the size and shape of the frontal sinuses, sopranos having long, narrow, frontal sinuses, mezzo-sopranos shorter and broader ones, and altos very short and almost round ones. The cases examined have run unusually true to type.

Second, the size or weight of the voice seems to be governed by the size of the antri, clear light sopranos having smaller antri than those having larger, heavier voices.

Third, the naturally beautiful voices seem to have arches, palatal and pharyngeal, that are symmetrical in their make-up, well-arched cases having more beauty in their voices than those having flat arches.

In cases where technical difficulties have been encountered by students examined by the writer and who had the advantages of study and training by excellent teachers, malformation of the frontal sinuses was apparent. In several cases a variance in the length of the right and left sinuses seemed to be the cause of irregularities in the vocal scale.

The same anatomical differences with consequent vocal changes appear in male voices.

A thorough investigation is under way by the writer, and plans are now being formed to radiograph a large number of distinguished singers' heads.

In all cases great care must be used in making all films with definite angles as the work can be accomplished only through comparisons.

Any comment, critical or otherwise, will be welcomed.

FRANCIS WHEELER

CENTENARY COLLEGE OF LOUISIANA

[1] Calkins and Bowling, *Biol. Bull.*, 51: 387, 1926.

[1] Published with the permission of the director of the Geological Survey, Canada.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MEETING OF THE EXECUTIVE COMMITTEE AT CLEVELAND, NOVEMBER 30, 1930

THE executive committee held three sessions at the Hotel Statler, in Cleveland, on Sunday, November 30. The morning session opened at 10:00, the afternoon session at 3:15 and the evening session at 8:15. Members who attended were: Cattell, Compton, Curtiss, Kellogg, Livingston, Ward, Wilson. Those absent were: Alsberg, Lillie, Millikan, Morgan Dr. H. W. Mountcastle, Dr. J. Paul Visscher and Messrs. A. J. Kennedy and A. C. Hancock, of the Cleveland group, were present at the evening session, by invitation, as was also Mr. Woodley, of the Washington office. The following items of business were transacted.

1. The minutes of the last meeting of the committee, at Berkeley, California, September 17, were reported as having been approved by mail.

2. The treasurer's report and the financial report of the permanent secretary, for the fiscal year 1929–30, were accepted. It was ordered that they be audited and presented to the council at the fourth Cleveland meeting.

3. It was voted that a special meeting of the committee on grants for research be called, with those members of the executive committee who may be able to attend, on Sunday, December 28, at the Hotel Statler, in Cleveland. The committee on grants was asked to consider at this meeting the whole problem of how the research funds of the association may be best used in the interest of the advancement of American scientific research. A report to the council at the fourth Cleveland meeting was asked for. Members of the committee on grants who attend this special session are to be allowed, in lieu of expenses, four cents a mile for the round trip and six dollars additional.

4. The special committee on the permanent secretaryship and related matters (Cattell, Livingston, Wilson) reported that 160 nominations for permanent secretary had been obtained by means of a questionnaire sent to all council members and members of the section committees. Fifty-seven favored a full-time position, of whom 37 were decidedly in favor of that arrangement. Twenty-eight favored a part-time position, of whom 9 were decidedly in favor of that arrangement. Forty-one favored retaining the office in Washington, 20 considered the location of the office as relatively unimportant, 2 were opposed to having the office in Washington.

The executive committee recommended to the council that the office of the permanent secretary be retained in Washington and that $8,000 be considered as the limit of available funds for the permanent secretaryship for next year. The special committee was asked to make definite recommendations to the council, at the Cleveland meeting, concerning the permanent secretaryship and the organization of the Washington office of the association.

5. An appropriation of $1,000 from the treasurer's funds, for use by the Committee of One Hundred on Research for the current fiscal year, was recommended to the council.

6. An appropriation of $300 was recommended to the council, for three emeritus life memberships.

7. The resignation of Dr. Rodney H. True, secretary of the Committee of One Hundred on Research, was accepted with regret. Dr. True's resignation is to be effective only after the fourth Cleveland meeting.

8. Dr. Charles A. Shull was appointed secretary of the council, to succeed Dr. Sam F. Trelease, resigned.

9. The rules for the award of the annual $1,000 prize were further amended as follows: The committee on award is to make its decision before leaving the meeting place, and public announcement of the award is to be made through the Association Press Service as promptly as possible, but not before the meeting has actually closed. The committee on award is to devote sufficient time to this decision, remaining a day or two after the close of the annual meeting. Each member of the award committee who thus stays over is to receive, in lieu of expenses, an allowance of $50. The subject of the prize paper for a meeting is to be specially presented at the next following summer meeting of the association if that is feasible, otherwise at the next following winter meeting.

10. An application for the official affiliation of the National Social Science Honor Society, Pi Gamma Mu, was received and referred to the section committee of Section K for recommendations.

11. The permanent secretary was asked to consult further concerning the best way for the association to cooperate with those engaged in dental research, especially with regard to the affiliation or association of dental-science organizations.

12. An appropriation of $3,000 from the treasurer's funds was recommended to the council, for

allotment by the committee on grants for research.

13. An appropriation of $500, or such portion thereof as may be needed, was made from the treasurer's funds, for paying the honoraria of the members of the committee on grants for research. (See 3, above.)

14. An appropriation of $250 from the treasurer's funds was made, to care for the honoraria of the members of the committee on prize award. (See 9, above.)

15. The committee looked with favor on holding the meeting of December, 1932, at New Haven.

16. A report from Dr. Gregory D. Walcott, chairman of the committee on Source-Books, was accepted and referred to the council.

17. Dr. J. McKeen Cattell was named to represent the American Association at the approaching Centenary Meeting of the British Association for the Advancement of Science, to be held at London, September 23–30, 193[illegible].

18. Dr. Robert A. Millikan was named to represent the American Association in connection with the American cooperation with the Royal Institution, for the approaching Faraday Centennial Celebration.

19. The executive committee favored having general-interest lectures at 4:30 on the afternoons of Tuesday, Wednesday, Thursday and perhaps Friday, as general sessions of the association, also general-interest lectures at general sessions on the evenings of Wednesday, Thursday and Friday.

BURTON E. LIVINGSTON,
Permanent Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD OF INJECTING THE COELOM OF SMALL ANNELIDS

IN the course of experiments involving the injection of various solutions into the body cavity of Lumbriculus, a microdrilous oligochaete, some modifications of the apparatus and methods described by Knower[1] were found to be advantageous.

Small glass bulbs and tubes similar to those described by Knower, but averaging about eight inches in length and with the right angle bend one half to three quarters of an inch from the end of the bulb, were used. In this work, however, the microinjector was held in a support consisting of a wire loop so shaped that adequate freedom of movement was possible (Fig. 1). This loop was attached to an adjustable burette clamp the jaws of which held a microburner inserted into a small cork. This burner was so placed that it pointed directly toward the microinjector bulb.

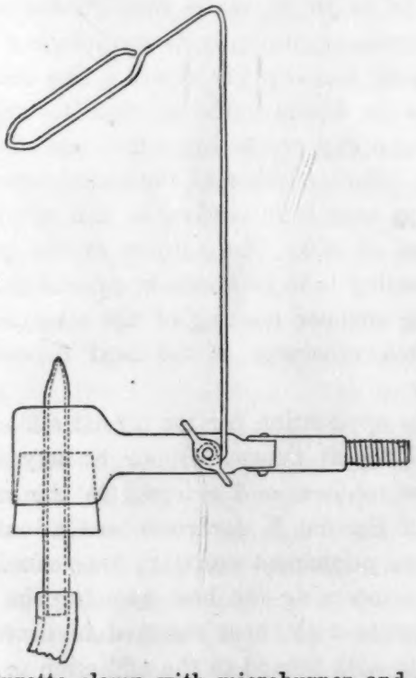

FIG. 1. Burette clamp with microburner and wire-loop-holder for microinjector bulb. One half actual size.

A rubber tubing leading to this burner was passed through a spring clamp of medium size. To keep the jaws of this clamp from completely closing down on the gas line a short piece of glass rod was fastened between them with sealing wax (Fig. 2, W). Consequently each time the clamp was allowed to close it left a small lumen in the constricted portion of the gas line. The clamp was adjusted so that when it was closed against the glass rod a flame about one half inch in length remained as a pilot light. The main gas cock was set to produce a flame which would just envelop the microinjector bulb when the spring clamp was opened. The spring loop of this clamp was slipped on the left fork of the stage of a Spencer convertible microscope in such a way that the jaws of the clamp were above and one of the finger grips rested against the upright part of the arm (Fig. 2). The clamp was held in this position by a wire wrapped around the microscope arm and slipped over the inner finger grip. In this position it could be opened by pressure exerted by the base of the index finger of the left hand, even when the other fingers were pressing down on the center of the microscope stage.

A special stage was made from a block of paraffin the ends of which had been cut so that they would

[1] H. McE. Knower, *Anat. Record*, 2: 207.

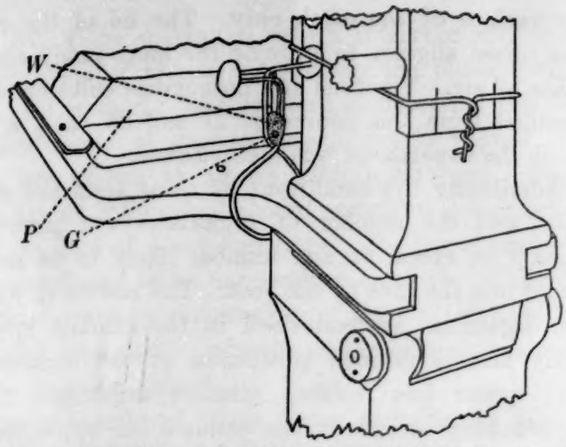

FIG. 2. Portion of binocular microscope showing method of attaching spring clamp for control of gas to microburner. Glass rod (G), held in place by wax (W), keeps clamp partially open. P, special paraffin stage.

slide under the stage-holders (Fig. 2, P). Parawax cakes are of a convenient shape and satisfactory consistency for this purpose. A straight, shallow groove, about two inches long and parallel to the front of the microscope, was cut in the center of the stage.

The injection procedure was as follows.

A microinjector, with bulb not over half filled with the liquid to be injected, was placed in the wire holder. The ring stand, carrying this bulb and the microburner, was placed at the right of the microscope at such a distance that the range of the pipette was over the groove in the paraffin stage. An individual previously anesthetized in one eighth of 1 per cent. chloretone was then transferred to the stage in a medicine dropper. After most of the solution had been removed, the worm was stretched out in the groove with the tip of its prostomium a short distance from the left end. A microscope slide or cover-glass was then placed over the anterior end of the worm, leaving several segments exposed anterior to the point at which it was planned to make the injection. A cover-glass proved the more satisfactory since its flexibility made it possible to vary the pressure exerted on the worm even though the latter did not quite fill the groove. With a few flashes of the gas flame the bulb was slightly warmed until the solution began to flow slowly in drops from the tip of the pipette. The cover-glass was then held down firmly with one or two fingers of the left hand, while with the right the end of the pipette was carefully inserted into the coelom of the worm and pushed anteriorly three or four segments from the point of entrance. Without removing either hand, the base of the index finger of the left hand was lightly pressed several times against the outer finger grip of the spring clamp to give brief flashes of heat to the bulb. If the bulb was heated too rapidly the side toward the flame became so soft that it could not withstand the pressure created within.

This method has the advantage that worms are held firmly in place while the solution is injected with a minimum of injury. The method of warming the bulb makes it possible to control carefully the flow of the injection-solution while both hands are at the same time occupied with other tasks. In addition the holder is simple, easily made and consequently more readily obtainable and less expensive than the type used by Knower.

LEONARD P. SAYLES

TUFTS COLLEGE

SPECIAL ARTICLES

THE VIRUS OF LARYNGOTRACHEITIS OF FOWLS

INFECTIOUS laryngotracheitis or infectious bronchitis of fowls has been recognized as a distinct and definite disease since 1924. The disease has become so highly destructive in the United States and Canada that it menaces the poultry industry in certain regions. There is no record of its occurrence in other countries.

The disease is now being studied with material obtained from four sources—two in New Jersey, and two in California. The poultry raising districts in California from which part of the material came have suffered severely from the affection during the past four years.

Bacteriological study having failed to reveal a consistent visible microorganism in association with the lesions of the disease, and spleens and livers, proved to contain the causative agent, having been bacteriologically sterile, a filterable virus was sought for and found in the inflammatory exudate contained in the tracheas of infected fowls.

Seven filtrations from the exudate have been made through five different Berkefeld "V" filters, and it was shown that infectious material was present in six of the seven filtrates. Of five filtrations made through Berkefeld "N" filters, three proved infectious and two non-infectious. In one of the five instances, the same material passed through a "V" filter was active. As yet no infection has been secured with material passed through Seitz filters. The incubation period of the filtrate inoculations has been the same as that of inoculations of non-filtered suspensions of the exudate.

Experiments on antibodies for the virus are in progress. Complete inactivation or neutralization of the virus has already been obtained when mixed with

serum from each of two recovered fowls, while in other instances the onset of the symptoms of infection has been much delayed.

J. R. BEACH,
Division of Veterinary Science,
University of California
DEPARTMENT OF ANIMAL PATHOLOGY,
ROCKEFELLER INSTITUTE FOR
MEDICAL RESEARCH,
PRINCETON, N. J.

THE LONGEVITY OF BACILLUS AMYLOVORUS (BURR.) TREV. IN ASSOCIATION WITH HONEY

IN recent years interest in the part played by meteoric water in the dissemination of the fire blight organism has diverted the attention of some workers from the long-established[1] rôle of pollinating insects as vectors. Gossard and Walton[2] in 1922 demonstrated that the organism may be found in honey from the beehive and that it may be recovered after 72 hours from artificially infested honey.

The results of the following experiments suggest that a more detailed examination should be made of the relation of the bee and the hive to the fire blight problem.

A heavy bacterial suspension in water was made from the exudate from blighted pear twigs. This was applied with a camel's hair brush to the outside surface of a frame of honey, to the surface of the comb and to the uncovered cells at the margin of the comb. The frame was placed in a covered glass dish without the addition of water and stored in a dark cupboard at laboratory temperatures (Berkeley, California).

Transfers were made to bouillon with flamed instruments at intervals of 3, 5, 7, 9, 11, 13, 15, 20, 30, 40 and 55 days from the time the experiment was started. Inoculations were made directly from the bouillon on green pear fruits in the laboratory or apple shoots in the greenhouse. In this manner the presence of the organism was demonstrated in the honey cells in every attempt up to 15 days but in no instance thereafter. It was recovered from the wood of the frame at 3, 5, 9, 11, 13 and 20 days. From the waxy surface of the comb virulent organisms were obtained in every attempt up to 55 days when the experiment was terminated.

A second experiment was made similar to the first with the following exceptions. Undiluted bacterial exudate from inoculated pear fruits was applied to the surface of the comb only. The lid of the dish was raised slightly to provide for more ready circulation of air. Vigorous and pathogenic cultures were obtained from this source at 21 and 35 days, after which the experiment was discontinued.

Admittedly the conditions of these tests are artificial and the number of organisms was probably greatly in excess of any number likely to be introduced into the hive by the bees. The matrix in which the organisms are embedded in the exudate apparently affords decided protection of the organisms. The writer has isolated virulent organisms from rather large drops of the exudate on apple twigs, after these had been kept dry in the laboratory for 12 months (at Ithaca, New York). It seems significant, however, that the bacteria remained alive on the surface of the comb 35 days longer than was the case on the surface of wood or in the honey. Although it seems impossible to standardize the samples from these three sources, it is of interest that the growth in bouillon was in most if not all cases more profuse with the sample from the comb than with the others.

Three important questions are involved here:

1. The organisms may be carried from blossoms into the hive and thence to other susceptible plants in the neighborhood.

2. They may be transferred from one locality to another when the bees are moved for the purpose of effecting pollination in orchards. (This appears to be a rather common practice in some districts.)

3. It is possible (though it seems improbable) that the bacteria may occasionally survive in the beehive from the time of the scattered late blossoms in autumn until the first blossoms which appear in the spring.

H. E. THOMAS
UNIVERSITY OF CALIFORNIA

THE CLARIFICATION OF PLANT JUICES: NITRATE CONCENTRATION IN LARGE AND SMALL LEAVES

IN view of the increasing interest in the chemical study of the expressed juice of plants, and the recent publications (Hill,[2] Cook,[3] McCool and Weldon,[4] Holtz and Larson,[5] Emmert[6]) on the determination of nitrate nitrogen in these juices, it may be of interest to describe advances in a method used in this laboratory (Gilbert[7]) for securing samples of plant

[1] M. B. Waite, "The Life-history and Characteristics of the Pear Blight Germ," *Proc. Amer. Assoc. Adv. Sci.*, 47: 427–8, 1898.

[2] H. A. Gossard and R. C. Walton, "Dissemination of Fire Blight," *Ohio Agr. Exp. Sta. Bul.* 357, 1922.

[1] Contribution No. 394 of the R. I. Agricultural Experiment Station.

[2] H. H. Hill, SCIENCE, 71: 540, 1930.

[3] R. L. Cook, *Journ. Am. Soc. Agron.*, 22: 393, 1930.

[4] M. M. McCool and M. D. Weldon, *Journ. Am. Soc. Agron.*, 20: 778, 1928.

[5] H. F. Holtz and C. Larson, *Plant Physiol.*, 4: 288, 1929.

[6] E. M. Emmert, *Plant Physiol.*, 4: 519, 1929.

[7] B. E. Gilbert, *Plant Physiol.*, 1: 191, 1926.

juice free from substances which interfere with the determination of nitrate nitrogen by the phenoldisulfonic acid method. The greatest modification lies in the elimination of carbon black, certain brands of which are known to adsorb nitrate nitrogen. The simplicity of the method should commend it to workers in the field of plant chemistry. The use of carbon black was found to be unnecessary since the colloidal complex formed by the reaction of the $Ca(OH)_2$ with the $CuSO_4$ and $AgSO_4$ adsorbs all the coloring matter present in plant juices.

Place a sample of plant tissue sufficient to yield approximately 10 cc of juice in a cheesecloth bag and freeze thoroughly for at least two hours. This is best done by solid CO_2, although an ice-salt bath may be used, if sufficient time is allowed for thorough freezing. Remove from refrigerating medium, thaw and press at once in any device which will give sufficient mechanical pressure. A hydraulic press of small size is extremely convenient for this expression, since it is essential that the pressure be the same on all samples if a comparison of the results is to be made. Collect the expressed juice, centrifuge to remove any solid material, and pipette a suitable aliquot (usually 2 cc) into a 100 cc volumetric flask.

To the juice in the flask add about 20 cc of nitrate-free distilled water; 5 cc of saturated $AgSO_4$ solution; 1 cc of N $CuSO_4$ solution, and 0.2 gram of finely divided $Ca(OH)_2$, shaking after each addition. These reagents should be thoroughly tested for the presence of nitrate nitrogen, and only those showing an absence of nitrates should be used. Make to volume with nitrate-free water, and filter after standing at least one hour. Discard the first portion of the filtrate. A suitable aliquot of this can be evaporated to dryness on a steam bath, and the nitrate-nitrogen determined by the phenoldisulfonic acid method, using NaOH to neutralize the acid according to Harper.[8] If a precipitate forms at this point, allow to flocculate and filter.

A detailed study of the method above proposed has been published.[9]

In connection with some determinations of the nitrate nitrogen in the juices of the beet plant, a significant negative correlation appeared between the weight of the leaves and the nitrate nitrogen found in the juice of these leaves. Upon further study, the correlation calculated from a statistical study of 578 individual leaves divided into twelve composite samples indicated a correlation of -0.855 ± 0.052. An explanation of this may be found in the following facts:

(1) The juice of the midrib of the beet leaf contains more nitrate than the juice from the remainder of the leaf.

(2) The ratio of the weight of leaf tissue after removal of midrib to the weight of midrib is much higher in the large leaves.

These facts offer an explanation for the correlation, for, since the high nitrate juice is in the midrib, and the proportion of the weight of midrib to the weight of the remainder of the leaf is greater in the small leaf than in the large, it is obvious that the smaller leaf should have a higher nitrate content.

In view of the above facts, it has become the practice in this laboratory to choose leaves of uniform size and to remove the midrib of these leaves before the extraction of juice for analysis. It is hardly probable that this entirely eliminates the error attributed to the size of the leaves, since considerable venous tissue remains, but it is felt that this error is much less when the midribs are discarded.

A more complete study of the above facts has been prepared, and will be published soon.

DONALD E. FREAR

R. I. AGRICULTURAL
EXPERIMENT STATION

[8] H. J. Harper, *Journ. Ind. Eng. Chem.*, 16: 180, 1924.
[9] D. E. Frear, *Plant Physiol.*, 5: 359, 1930.

THE GEOLOGICAL BACKGROUND OF PEKING MAN (SINANTHROPUS)[1]

THE *Sinanthropus* discoveries are significant for a number of reasons, quite apart from the valuable evidence they present regarding the close relatives of the anthropoid stock from which the genus *Homo* evolved. (The anatomical facts themselves are made available through the reports issued periodically by Dr. Davidson Black from the laboratory of Cenozoic Research in Peiping. Therefore, beyond brief comments on the cast of the skull and on the photographic reproductions thrown on the screen, this short outline of the salient points deals with other aspects of the discoveries, which are reported officially in the publications of the Geological Society of China.)

(1) The story of the discovery at Chou-kou-tien offers a striking example of the romance of scientific research, beginning with Andersson's studies of the Tertiary and Quaternary history of North China, and his search for fossiliferous deposits (1921), followed by Zdansky's careful paleontological work on the mammalian remains (1922), and the finding of the first teeth when the material was being prepared in the laboratory at Upsala (1926); continued by Bohlin's methodical excavation leading to the unearthing of the single tooth on which Black based the new

[1] Abstract of paper presented at the meeting of the British Association, Bristol, by permission of the director of the Geological Survey of China.

genus *Sinanthropus* (1927); carried on by Pei's further discoveries of teeth, jaw and skull fragments (1928), and culminating in the finding of the uncrushed skull on December 2, 1929; and the reconstruction of the second skull six months later.

(2) Unlike the scanty remains of *Pithecanthropus* and *Eoanthropus* the material available in the case of *Sinanthropus* represents parts of ten individuals. It is surprising that all the material recovered is from the head, no limb bones having been so far recognized.

The most perfect skull is complete down to the roof of the orbital cavities, and has unfused sutures, being of a young adult.

It may be added that no stone implements or other sign of culture have been found.

(3) The main fossiliferous deposit occupies one of a series of old caves following former underground solution-channels in tilted strata of Ordovician limestone. It consists of a series of roughly stratified reddish sands and gravels, locally cemented into a tough travertine, mixed and interlayered with gray limestone breccia, due to the progressive collapse of the roof as the floor was built up. Probably at no time was the open cavity as high as the present depth of the deposit. The latest finds owe their preservation to the protection of a choked lateral conduit branching from a low level in the main cavity.

(4) As a minor point may be mentioned the accessibility of the locality. Chou-kou-tien is a village on the edge of the Western Hills, 45 miles from Peiping, which, on account of its coal, limestone and granite, is served by a branch of the Peking-Hankow Railway. Though not of use for passenger service, this railway has allowed the removal of great quantities of unprepared fossil material which can be carried away in bulk, to be worked up in the laboratories in Peiping. During the seasons 1927–29 1,475 cases of fossils were taken out in this manner. In addition, the quarrymen of the place are available for the task of blasting out the limestone and travertine walls, and excavating the less consolidated parts of the deposit in which the fossils occur. Thus, during the same three seasons a total of 8,800 cubic meters was excavated, despite the fact that the countryside has undergone a period of severe military and political disturbance.

(5) Parts of *Sinanthropus* have been found at five distinct levels, separated by as much as 60 vertical feet of deposit. The same is true of much of the mammalian fossil material, thus showing that the entire deposit is essentially of one and the same geological age. There is thus no chance of error in dating any particular horizon within the body of the deposit.

(6) The faunal assemblage is very rich, well preserved, varied in character, and suited to exact dating in terms of Chinese geological chronology, as well as of value in determining the climatic and environmental habitat of the period. Over fifty mammalian types, besides frogs, snakes, turtles and birds, have been already distinguished, and when comparative studies have been made should permit of close correlation with fauna in other parts of the world. Most characteristic types are *Sinanthropus* ("Peking Man"), *Euryceros* (flat-antlered deer), *Rhinoceros*, cf. *sinensis, Hyaena sinensis.* Interesting types are the big beaver (*Trogontherium*), primitive buffalo (*Bubalus*). There are suggestions of a southern affinity. It is distinctly older than the Loess fauna (Middle Pleistocene), which includes *Rhinoceros tichorhinus, Hyaena crocuta, Cervus elaphus,* in place of those mentioned above. The general assemblage is Villafranchian in type and can be closely dated as very early Pleistocene in view of the absence of truly archaic types, and the presence of modern types, including *Equus;* but it is definitely distinct from and older than Middle Pleistocene. This age tallies with the physiographic and climatic stages as determined from entirely independent evidence in other localities in North China.

(All new data are issued from the Laboratory of Cenozoic Research under the control of the Geological Survey of China and the Peiping Union Medical College. A bibliography up to December, 1929, appears in a paper by Teilhard and Young in *Bull. Geol. Soc. China,* Vol. 8, No. 3, 1929. Further data appeared in Vol. 9, No. 1, 1930.)

GEORGE B. BARBOUR

YENCHING UNIVERSITY

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